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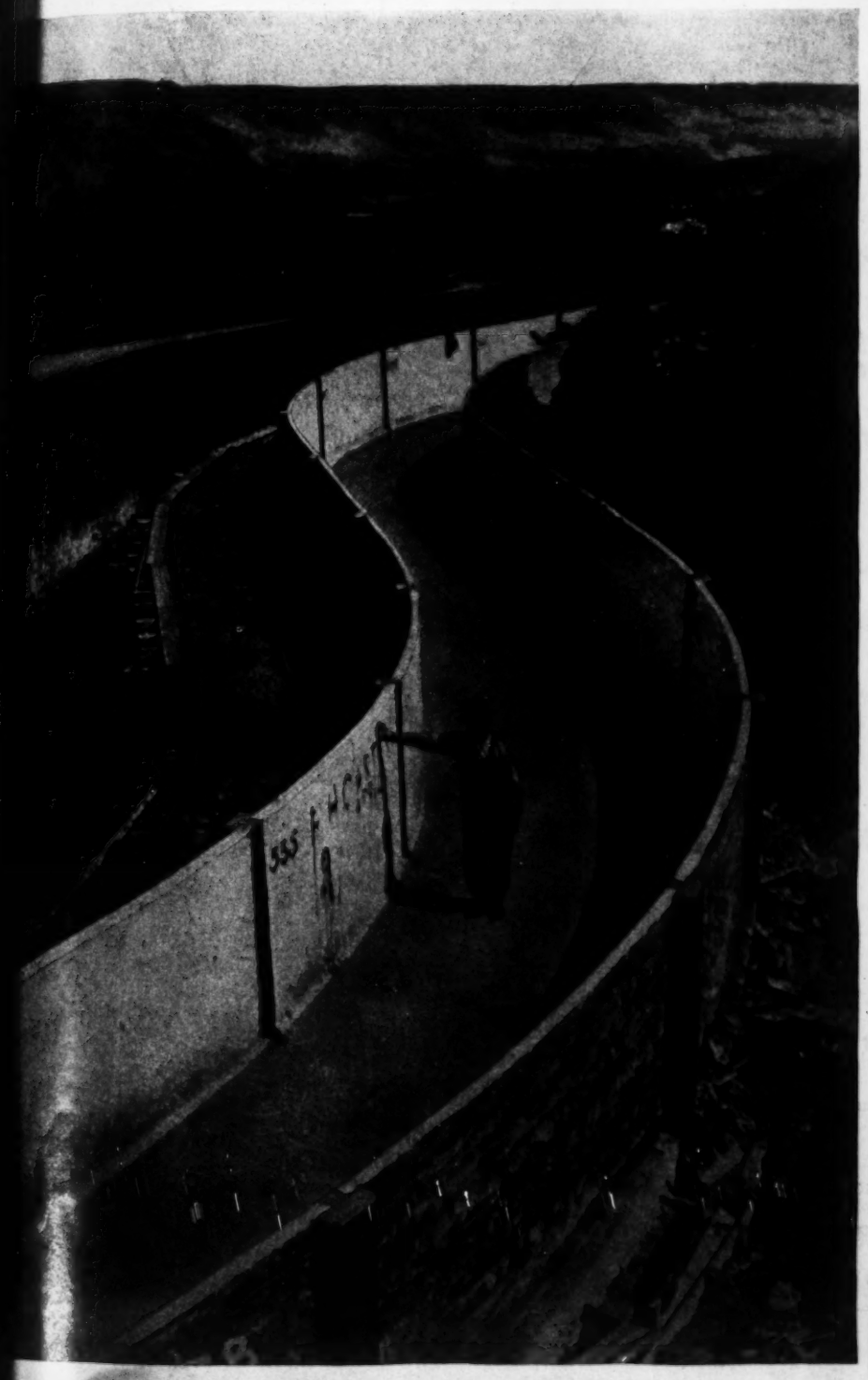
Engineering News-Record



WHAT the U. S. Reclamation Service has learned in two-year service tests at one of its projects.

Five Types of Concrete Flumes Described and Compared By Walter Ward

STEEL-LINED plates for roof support and concrete deposited through holes in ground on Detroit Sewer Tunnel.

Construction Systematized in Soft Ground Tunnel

U.S. Bureau of Public Roads gives results of research on concrete and brick types to aid road design.

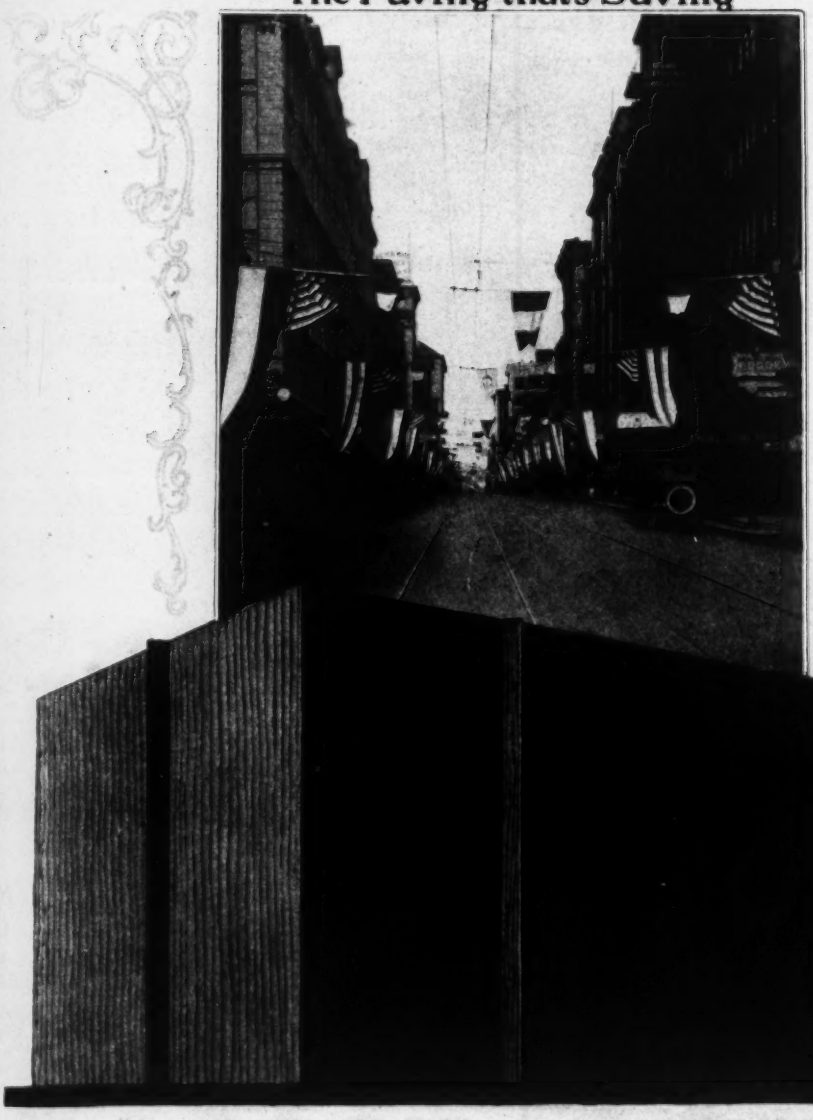
Effect of Impact on Pavement Slabs Shown By Tests

RUSTING of reinforcement in columns, chords and railing causes trouble in two 12-year old concrete viaducts and trusses.

Nashville Concrete Bridges Show Serious Deterioration

KREOLITE LUG WOOD BLOCKS

"The Paving that's Saving"



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. Mehren
Editor

Volume 87 — NEW YORK, DECEMBER 8, 1921 — Number 23

Bond Market Improved

IN ABSORBING power and in price, the market for city, state, and utility bonds now shows a marked improvement. Gilt edged municipal bonds for some time past have commanded a yielding or net return interest rate of 5 to 6 per cent, and utility bonds have been 1 to 2 per cent higher. Last week Pennsylvania state highway bonds, offered at 4½ per cent, brought such a premium as to reduce them to a 4.2 per cent basis. There is also a substantial improvement in city bonds and the utility bond outlook is better than before. Some of this upward trend in prices is due to year-end conditions, so that as these pass and as new bond issues are rushed forward to take advantage of the favorable market, some reaction may be expected, but there is reason to hope that this will not be enough to offset the upward trend. The reduction in interest charges will encourage city, county and state governments, and utility companies as well, to start long delayed and much needed improvements. This, in turn, will help all industry. The outlook for 1922 is brightened correspondingly.

Sanity in Working Agreements

LAST WEEK'S decision of the Railroad Labor Board with reference to the working rules of the shop-craft unions marks a return in railroad circles to some measure of sanity in reference to the jurisdiction of the crafts. The vicious rules obtaining under the national working agreements, whereby journeymen were obliged to do many things that could as well be done by common labor and helpers, and under which even minor repairs could be performed only by the journeymen of the appropriate craft, are swept aside. Now a boiler-maker will be permitted to handle work of another craft incidental to his duties, whereas before, he had to stand idle until a journeyman of the other craft was secured to do even ten minutes of incidental work. Likewise laborers and helpers may be employed for tasks that they can perform but which heretofore had to be done by journeymen. It is to be hoped that the start made in the elimination of these rules in the railroad shops and the equally conspicuous beginning made by Judge Landis in abrogating equally vicious rules in the building trades at Chicago will spread throughout the country and to all classes of work. The unions cannot expect to regain public sympathy if they persist in gouging the public by such dishonest working rules. They must get the conception that only by contributing to the economic strength of the country can they permanently prosper.

Practical Research

OF THE five types of concrete flumes described and compared in detail in the article in this issue everyone, says the author, Mr. Ward, will give service "sufficiently satisfactory to justify their creation." However, the first type built was not "sufficiently satisfactory" to the engineers and they pushed on from one type to another, keeping the costs approximately the same until they had developed two types, the semi-precast and the jointless monolithic flume, which they believe have slight advantages over the other types. Further, the original bell-and-spigot type they class as obsolete. This is research of the most desirable sort. The comparisons are particularly valuable inasmuch as the conditions to be met are alike as to inaccessibility and construction difficulties but sufficiently varied in character of foundation and location on the sloping canyon side to make them generally applicable in the irrigated regions. The necessity of finding a way to expedite construction during the short available working period between irrigation seasons is almost wholly responsible for the development of the semi-precast type which in the end proved as good as the best. As a short working season is generally common to reconstruction work on irrigation projects, this type will probably receive much attention in the future. While the Reclamation Service engineers are decidedly against calling the King Hill flumes an experiment, nevertheless the work they have done on them and the progressive design and construction methods aided by operating observations show how a large organization can add to engineering knowledge and at the same time serve its own structural needs.

Engineers or Builders?

SEVEN men were crushed to death last week by the collapse of a half-erected theater building in Brooklyn. The design of the structure contained no obvious faults, but the collapse appears to be chargeable essentially to that sordid cause, shoddy workmanship. In the erection of buildings this evil is more common than in other construction, and it has made a rather bad record, though not all of it marked by fatalities. Throughout the history of building it has been shown again and again that trying to "get by" with bad work leads to failures. Repeatedly our columns have emphasized the danger of shoddy building work, and advocated reliance on the professional warranty of architect's or engineer's supervision as a safeguard. We would again urge this remedy on the occasion of the present accident, which occurred under the system of supervision by the owner, acting as his own contractor. That the plan of professional supervision has not found acceptance hitherto may indicate that the public is unwilling to place so much responsibility upon one class, or perhaps that it considers the plan ineffective. At any rate, as yet no community, no city or state has made professional supervision of building a legal requirement. A radically different method of control has been advocated by some building officials, and we believe also by a number of architects, and is again brought forward on the occasion of the present accident: that builders be licensed—presumably on proof of competence—and that no building operations be permitted except under direction of a

licensed builder. There is undoubted promise in such a system, though no practical trial has been made. But is it more than merely promising? Its workability and effectiveness are open to doubt, to say the least, and pending a more convincing showing in this respect than has yet been offered we shall continue to believe that compulsory supervision of building work by the engineer or the architect is the true way out of the present condition. As a help toward clearing up the existing uncertainty on the subject, the advocates of the builders' license system would do a service to the community if they would present a thoroughly argued plea for their proposal, explaining at the same time why professional supervision would fail to accomplish the results sought.

Steel Versus Masonry

ONE salient point in the description of the Brooklyn theater wreck printed on p. 954 invites thought. The steel roof trusses of the structure rested on pilasters of the brick walls, not on steel columns, and two or three of these pilasters were found crushed or sheared at the top. Failure of a single one would have sufficed to bring down the roof structure substantially as it lies. Without forestalling the findings of the criminal authorities engaged in investigating the accident, we may assume that such failure was the initial cause. It was, at any rate, a *possible* cause, and one that would have been eliminated had steel columns been provided to carry the trusses. Is it not time, in the development of building practice, to demand that building laws should require steel supports for heavy steel carrying members such as trusses or girders? There has been a growing tendency, these many years, to avoid placing heavy concentrated loads on the brickwork of buildings, and to restrict the load-carrying functions of the masonry to minor service, a limitation justified by the inevitable uncertainties of load distribution where steel main members are supported on brickwork. This development has taken place in the face of the fact that every one recognizes the strength and dependability of well laid masonry whether stone or brick. One difficulty is that the excellence of workmanship and the perfection of bearing and bracing to secure the load distribution aimed at, and to avoid disintegrating actions on brickwork, are far less easily obtained than ample design and thorough workmanship in a shop-fabricated steel column. Building regulation, we believe, aims to establish the safer practice of two alternatives; the principle involved herein well warrants the requirement of steel column supports.

A Subject for Further Study

THERE will be those who see in the article on the Nashville concrete bridge deterioration only destructive criticism, who will say that because no definite explanation is given of the serious condition of many of the slender supporting members of these bridges, such publicity will only cause unfair discrimination against concrete and unnecessary uneasiness regarding other concrete structures. The answer to this is that the conditions described actually exist and that that existence is a matter of vital moment to all engineers. If cognizance of them were to be withheld until all the reasons why they occurred were made available they might remain known only to those engineers who might happen to be in Nashville. It will be quite easy to say that if the concrete had been made of proper materials and in proper fashion the structure would be in as good condition as are dozens of similar contemporary structures, but that is a negative way of looking at such cases, all too common in the study of concrete failures, partial or complete. An exhaustive study of the Nashville bridges should be made. The engineers who report on it in this issue have given it all the study their resources command but they would be the first to advocate a thorough investigation of the structures, both into the history of the concrete, the methods and materials used in making it, and into the physical properties of the concrete as it exists today. This is plainly a case of steel corrosion and corroded reinforcement means a porous concrete and the presence of water. What we want to know is the cause and extent of the porosity in the Nashville concrete. Any peculiarities of exposure are quite secondary. The city of Nashville will save its engineers some worry and possibly itself some damage suits if it considers its duty to lie beyond a mere superficial repair of the weakened members.

Well Preserved Cables

IN THE demonstration made last week of the well preserved condition of the Williamsburg bridge cables a valuable piece of evidence has been made available as to the permanence of our large bridge structures. As reported on p. 939, this demonstration, together with the fuller inspection data which it is hoped may be published in the near future, gives fair assurance that the main parts of the great New York suspension bridges have an indefinite length of life (we are tempted to say, unlimited life). Such bridges, in other words, are not subject to perceptible decay, and so far as corrosion is concerned they may remain free from measurable deterioration if intelligent inspection and maintenance are applied. As we look at the ancient stone bridges of Europe we reflect with wonder and admiration on their endurance through the ages; yet it is not beyond the bounds of possibility that our great steel bridges may survive as long. Quite generally the world has been content to look upon iron and steel bridges as short-lived, built today and rusted out tomorrow. But with the proof from experience that carefully maintained structures are by no means perishable but continue in service with no noticeable deterioration, these views need to be recast, and bridges come to be looked upon as enduring works, whose planning merits the same scrupulous consideration of long-time needs as does that of harbors or power developments. These facts have been becoming evident for a good while past, with doubt, however remaining as to the internal preservation or deterioration of large suspension bridge cables. The information on the latter point which Mr. Byrne is now bringing out tends to establish this conclusion much more firmly by guaranteeing the enduring qualities of the type of structure upon which some of our most vital highway communications depend, namely, the wire cable suspension bridge.

Disarmament Conference and Business

IT WAS to be expected that after the first interchange of generalities the disarmament conference would settle down to laborious discussion of detail in which there would be a conflict of opinion. Not only that, but playing for advantage was to be expected. In turning into these channels the conference is merely "running

true to form." Nevertheless, the healthy impression made on the business tone by the conference keeps up. It is right that it should be so. It seems inconceivable that the conference will adjourn without very substantial advantage; even a small one will have a favorable effect upon the business sentiment. A feeling of greater security, a relief from the burden of financing armaments, the release of men for productive enterprise—all of these must have a favorable influence on the business situation. They are right, therefore, who hold an optimistic attitude, who see in the disarmament conference another augury of continued and increasing revival of business.

Contracting Not Developing Its Technique

UNIFORMITY develops slowly in methods of construction. Sewer tunnel construction in Detroit, Mich., one method of which is described in this issue, is an illustration. Here, with a uniform soil and the experience of a score of contractors on similar operations, there is as great a variety of equipment and as many processes now as there were when the first contracts were let over two years ago.

In road building, where, again, conditions favor standardization of methods and equipment, there has been almost no progress toward uniform practice in the last three years of intensive paved road construction. There are fewer methods now than formerly because a whole group has been eliminated by the recent requirement of highway engineers that materials cannot be stock-piled on the subgrade. Standardization is in no degree responsible.

Two facts appear to account for this slow progress toward uniform construction methods. One is that fewer opportunities exist in construction than in industrial processes. For this condition there is no remedy.

The other fact is that where standardization may be practicable, contractors do not possess the information required for determining equipment or procedure. Not only is the information lacking, but contractors are making no appreciable effort to provide it. This condition can be changed by proper effort.

Who will make the effort? The individual contractor will not; he will seldom make known the information on which he bases his own choice of plant and procedure. If he did so generally, there would still be necessary some agency to co-ordinate the information and formulate preferred practices.

Obviously this agency should be organized contracting; it has the most to gain. When all is said that can be said of the importance to the contractor of the business of contracting—the organizing, financing, purchasing and the hiring of labor—the engineer and the owner regard this as the contractor's personal concern and judge him, as a contractor, by his skill and efficiency in constructing. In its justifiable efforts to improve its business relations and practices, contracting cannot, therefore, afford to neglect technical proficiency nor any means by which can be increased the confidence of the engineer and owner that contractors have this qualification.

There is real need of increased confidence in the contractor's technical efficiency. In road building, which is now engaging more contractors than any other kind of engineering construction, contractors are criticised more for their lack of definitive practice, their haphazard choice of equipment and methods, than for any other fault. It indicates, it is charged, that contracting is not developing its road building technique. State highway departments have undertaken force account construction in many instances so that they might compare methods and processes, which contractors are not doing, and obtain the essential facts, which contractors are not getting, for determining the preferable methods and plant under different ordinary conditions.

Contractors should be doing their own technical research and should be establishing economic construction practices for themselves. They are organized, through the Associated General Contractors, to perform the task. The association has done much to bring uniformity into estimates for road work and in analyzing forms of contracts. The same activity in establishing preferred practices in construction for various kinds of work where the conditions are reasonably uniform, as in road construction, is badly needed. Preferred practices and technical proficiency should be emphasized in the plans for 1922 to be formulated by the association at its annual convention next month in Cleveland.

An Academy of Labor

LAST MAY there was undertaken at Frankfurt-on-Main, a new experiment in trying to give the workers, and employees generally, a thorough grounding in the principles on which our economic and political structures are built. There was initiated at the University of Frankfurt an Academy of Labor with a teaching staff detailed by the Prussian Ministry of Education and with more than 100 students selected by their respective labor and employees bodies. The classes for the first school year are still in progress and will not terminate until next February. In order that well qualified persons might form the student body, the labor organizations are undertaking to pay all the living expenses of their representatives, so that, care free, they can pursue their studies.

The particular object in instituting the academy at the present time is to bring to the restoration of Germany whatever of value can be developed by contact between experience and theory. The principle on which the classes are organized is to examine the experience of the workers in the light of theory, the expectation being that there will be a modification of the views of the teachers, and possibly of the students as well.

Those directly concerned with the experiment are not ready yet to reach conclusions regarding its success, but the hope is entertained that it will be of assistance to solid thinking and a helpful factor in Germany's reconstruction.

The idea, generally, fits in with that which has been frequently urged in these columns, that the American Federation of Labor needed to form its program on the basis of fundamental instead of on fighting issues whose strength lies merely in their appeal to the unthinking. At times in the last two years there has been a hopeful note in pronouncements of the federation, but within the last six months, since unemployment and resistance to union domination began to make such inroads upon its influence, the federation has lapsed back into its old fighting spirit. In that direction there is no hope for a solid improvement—at least as far as the influence of the federation is concerned—in the relations between employer and employee.

Concrete and Gunite Flumes on the King Hill Project—I

Five Types Compared as to Cost, Maintenance, Construction and Serviceability—Semi-Precast and Monolithic Flumes Have Slight Advantages

By Walter Ward
Project Manager, King Hill Project, U. S. Reclamation Service, King Hill, Idaho

Probably every reasonable type and combination of types of concrete and gunite flumes are included in the list of structures built on the King Hill Project by the U. S. Reclamation Service under Mr. Ward's direction. All of the flumes have now seen service through at least two seasons. In the summer of 1919 a representative of "Engineering News-Record" happened in on Mr. Ward and made arrangements for the present article after a day's trip over the work which had then reached the stage of preparations for the final type of flume tried—the semi-precast. So valuable was the data then available to the irrigation engineer, who because of the widespread drouth was that year as never before confronted with the necessity of waste prevention, that Mr. Ward consented to the preparation of a brief preliminary article (see "Engineering News-Record," April 1, 1920, p. 661). His consent was only obtained, however, under the promise of an opportunity to "clean up" the subject at a subsequent date when a full report backed by the experience of at least a full year's operation could be presented. Since Mr. Ward prepared the article another irrigation season has closed but he writes that no changes are necessary.—Editor.

FIVE different types of reinforced-concrete flume on the U. S. Reclamation Service King Hill Project, Idaho, have been tried out and comparative experience is now available. The types are semi-precast and monolithic (called hereafter concrete), gunite, combination gunite-and-concrete, and concrete with bell-and-spigot joints. The first two are the least expensive to build but the others have proved sufficiently satisfactory to justify their erection.

Some types have marked advantages under certain conditions. All are safe on rock foundations, the choice then being left entirely to first cost, maintenance and estimated useful life. Flumes without joints, either concrete or gunite, will have a lower maintenance charge than the flumes with joints. Where the foundation is clay, or loam which might become saturated with water and freeze in winter or which might settle under the flume during operation, flumes with joints are not safe. On such foundations with continuous flumes either concrete or gunite, there is considerably less chance of heaving and little if any chance of erosion.

Bell-and-spigot flume should probably be considered an obsolete type as it has the highest cost, probably the shortest useful life, and the following disadvantages which do not obtain in the other types: Unless located on rock the leakage causes erosion with ultimate settlement and failure. Freezing throws the sections out of grade further increasing the leakage and decreasing the capacity. Provided it has a suitable foundation the semi-precast has a marked advantage when the building season is short.

A gunite flume would not prove economical unless a considerable volume of work is undertaken, as it requires a larger amount of special equipment than a concrete flume, and skilled operators. Until the useful life period is known no choice can be made between the concrete flume without joints and the combination gunite-and-concrete type. Local conditions and first cost must then govern. On this work the former is slightly cheaper. In the gunite flumes the cross-ties present a barrier against which weeds and floating débris lodge.

The King Hill project is a long narrow project with a main canal 52 miles long taking its supply from the Malad River, a spring-fed stream tributary to the Snake River. It furnishes an unfailing supply of 300 sec.-ft. A large part of the canal system is located in the Snake River canyon in south central Idaho and crosses numerous gulches, creeks and is four times siphoned across Snake River. Wherever the topography and soil formation permit, the canal is an ordinary earth channel, but the long stretches of the canal located in the Snake River canyon are on side hill slopes so steep that the only type of structure feasible is a flume built on a bench excavated in the hillside. The Snake River and the deeper gulches and creeks are crossed by means of inverted siphons. There are seventeen of these siphons on the main canal ranging from 48 in. to 100 in. in diameter. The main canal consists of 37½ miles of open earth channel, 5 miles of pipe line and 9½ miles of flume.

In *Engineering News-Record*, April 1, 1920, p. 661, was a brief account of the reconstruction program together with a description of the early history of the project from its opening in 1908 leading up to the contract in 1917 between the State of Idaho and the King Hill Irrigation District, and the Reclamation Service whereby the latter agreed to reconstruct the project to prevent its reversion to desert. At the end of nine years many of the wooden flumes and siphons had nearly reached the end of their useful life.

After an examination by the engineers of the Reclamation Service of the wooden structures that were then in place, they decided that a more permanent type of construction was absolutely necessary for the success of the project. Several types of flume were studied, the principal ones being semi-circular wood-stave flume, metal flume, gunite flume and concrete flume. The factors influencing the type of structure to be built were the first cost, the useful life, the ultimate cost and the service that each type could be expected to give. Estimates made in 1917 based upon the cost of both labor and material prevailing at that time indicated that a semi-circular wood-stave flume with an estimated useful life of 20 years would cost $9.20 per lin.ft. A 14-gage galvanized-metal flume with timber sub-structure resting on concrete sills would cost $12.40 per lin.ft. and would have a useful life of 20 years. A

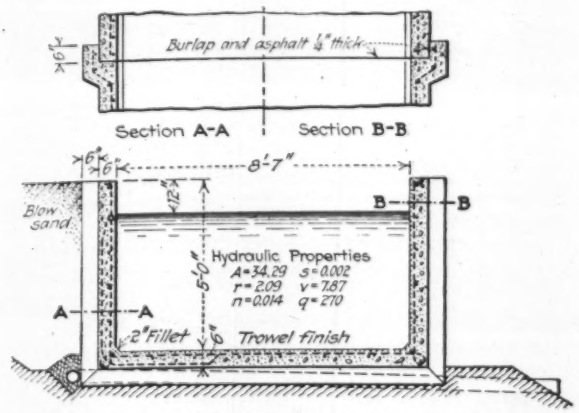


FIG. 1. DETAILS OF THE BELL-AND-SPIGOT FLUME
Longitudinal rods = ⅜" diam. 12 in. c. to c.
Transverse rods = ⅜" diam. 9 to 11½ in. c. to c.

gunite flume and a concrete flume, each with an estimated useful life of 50 years, would cost $12.50 per lin.ft. For purposes of comparison all estimates were based on a carrying capacity of 300 sec.-ft.

It was decided that the ultimate cost of the gunite and concrete flumes would be considerably less than either the wood-stave or metal flume, due to the fact that they would have so many years greater useful life. Also these flumes were more watertight, which fact alone would tend to eliminate either of the other types, because much of the foundation is of such a character that it will erode and settle rapidly under a flume which has any considerable leakage.

Concrete Flume with Bell-and-Spigot Joints

A concrete flume with bell-and-spigot contraction joints, one of the first built, was adopted because a flume with contraction joints at frequent intervals requires such a small amount of temperature steel that it was assumed that the cost would be materially reduced. Further, the fact that flumes built heretofore without contraction joints and with only a nominal amount of temperature steel had not been entirely satisfactory where there was a range of temperature similar to that of southern Idaho. The 6-in. side walls of this flume are reinforced as cantilevers so that no cross-ties are necessary. Although the flume will carry the required capacity with a freeboard of 1 ft., the side walls are designed to withstand the load with the flume running full. Additional reinforcing steel was placed in the bank wall wherever it was expected that sand would collect behind the flume and subject this wall to external pressure. The comparatively small amount, 0.181 per cent, of longitudinal steel used as reinforcement against temperature changes has proved ample, as some sections of this type of flume have been in service for three years and no temperature cracks have developed.

Contraction joints with an elastic filler were spaced on tangents at intervals of 22 ft. 9 in. for bell sections and at intervals of 24 ft. 3 in. for spigot sections. Both sections are 6 in. shorter on curves to permit of the economical use of the same length steel as used in the tangent sections. The extra length of the longitudinal bars on the inside of the curve was cut off and used to lengthen, with a 1-ft. lap, the corresponding bar on the outside of the curve. Before adopting this contraction joint consideration was given to various types with distances between joints ranging from 10 to 100 ft. It was deemed necessary that this contraction joint should (1) not weaken the flume section; (2) should be provided with a filler of some elastic material that would prevent spalling of the concrete due to expansion; (3) should be easily and cheaply constructed and (4) should be watertight. It was decided that the bell-and-spigot joint with either burlap soaked in asphaltum or a wooden filler would most nearly meet requirements.

The economical spacing of the contraction joints was a subject of considerable study. One contraction joint, regardless of distance between joints, was estimated to cost $13.10. The cost per linear foot of flume due to the joints would therefore be inversely proportional to the distance between joints. On the other hand the amount of steel required for temperature reinforcement

FIG. 2. BELL-AND-SPIGOT TYPE IN PLACE

increases with the distance between joints. Computation based on these two factors showed the economical spacing to be approximately 24 ft.

Experience demonstrated that the results of these computations were erroneous as they did not take into account the fact that all the work of building forms and placing concrete was retarded on account of these joints; therefore, the figure of $13.10 used as the cost of a contraction joint is considerably too low. Later estimates giving proper weight to all these items showed the economical distance to be at least three times the distance used. In fact the amount of longitudinal steel required for temperature reinforcement in a section thus determined would approach so closely the amount needed in a flume without joints that the cost of the two types would be approximately the same instead of being in favor of the contraction joint type as supposed.

Of the two kinds of filler used in the contraction joint, the first was designed to allow the flume to be poured continuously and consisted of a 1 x 6-in. board to provide the elastic filler between two adjacent sections and an 8-in. strip of 22-gage metal coated with asphalt to separate the bell from the spigot and provide the slip joint. It was expected that this board-and-metal strip could be held in position while the concrete was poured on each side simultaneously, completing the joint. It was found to be very difficult to hold this board and the metal strip in place while the concrete was being spaded and they were frequently crowded out of position, to a large measure destroying

the utility of the joint. This filler was therefore abandoned in favor of one made of burlap strips soaked in asphalt.

One objection to a filler of the latter type is that it cannot be placed until after the bells have been poured and the forms stripped, which necessitates the building of the flume in alternate sections requiring twice as many forms to accomplish the same amount of work daily as a flume that can be poured continuously. The fillers were at first made by dipping the burlap strips in hot asphalt. The difficulty experienced in placing them so that they would not wrinkle and form pockets at the joint was overcome by laying the burlap strips in a form of the required length and width and then filling the form with the hot asphalt. A filler made in this manner is much more pleasant to handle, does not wrinkle and makes a better and tighter joint. The slip joint was made by substituting a strip of the burlap and asphalt for the sheet iron.

The location survey was made to fit the existing bench as closely as possible, keeping the flume at all times on an undisturbed and solid foundation. The curves were made true arcs, and at first had center-line radii of 50, 75, 100 and 200 ft. Later the use of the 75, 100 and 200-ft. radii curves was discontinued and 50-ft. radius curves only were used. The adoption of the sharper curve reduced the length of curved flume and simplified the form work. About 30 per cent of this flume is on curves and as the form work on curves cost 50c. per lin.ft. more than on tangent, every effort was made in the location to reduce the curvature. This additional amount could be spent on excavation to eliminate curvature.

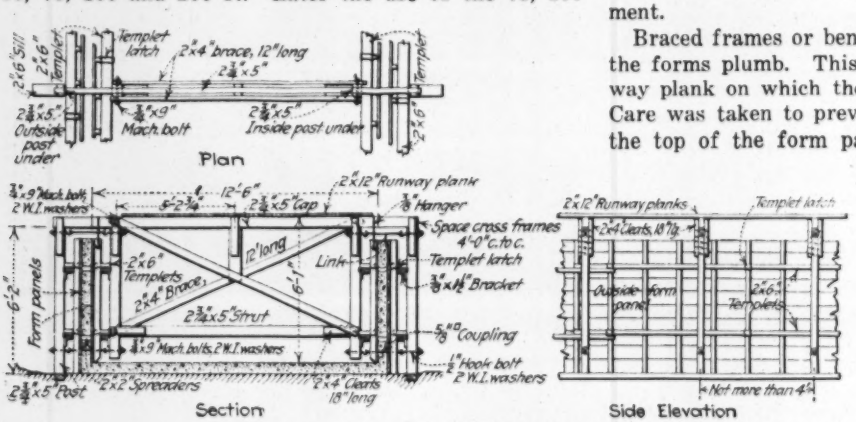


FIG. 4. FORMS FOR NO-JOINT FLUME

Teams and scrapers were used as far as possible in the excavation, although considerable hand work was necessary on the hillside in opening it up before the stock could get a footing. After the teams had roughed out the bench some hand work was then necessary to finish the subgrade.

Approximately 450 ft. of re-usable timber form panels were needed for each crew building flume. It was neither practicable nor economical to make sufficient forms to have exactly the proper panel length for all combinations of curves and tangents at the beginning and end of curves; therefore, a part of the panels was made of proper lengths to fit exactly the inside radius on the sharpest curve (which would be the shortest possible panel length) and the remainder to fit exactly the section on tangent (which would be the most common length used and also an average length on curves). Some combination of these panels would usually either fit exactly or lack only a few inches of closing at the mid point. Wherever this gap was less than 1 ft. a 16-gage sheet-iron plate was tacked on the inside of the form to close it. Where the gap was more than 1 ft. one or more short panel forms of 1 ft. or 1½ ft. length were used with the sheet iron. A supply of templets, either straight or cut to proper curvature, was made and bolted to the back side of the panels as they were erected to hold the forms to proper alignment.

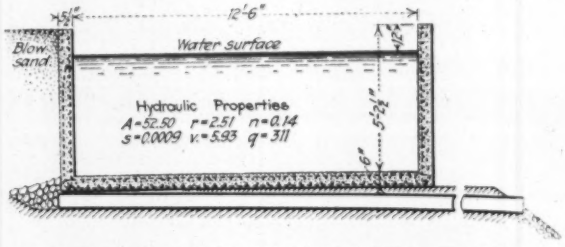


FIG. 3. DETAILS OF NO-JOINT CONCRETE FLUME

Long. Reinf. = ½ in. sq. bars, 4⅜ in. c. to c.
Transv. Reinf. = ⅜ in. sq. bars, 11½ in. c. to c.

Braced frames or bents were used to stiffen and hold the forms plumb. This frame also supported the runway plank on which the concrete carts were operated. Care was taken to prevent the frame from resting on the top of the form panels and subject the concrete, when partially set, to the vibration incidental to wheeling the concrete carts over the runway.

Forms for 450 ft. of flume, in use two seasons with some repair work, were worn out after being used to build 6,000 ft. of flume. If used continuously they would have lasted somewhat longer.

Snake River was the only source of water supply available for construction work. Triplex pumps with a capacity of 60 gal. per minute, driven by gas engines, were installed at convenient points along the river, and the water was pumped into temporarily constructed tanks located at points from 60 to 200 ft. in elevation above the flume bench, making a total lift of from 360 to 500 ft. This pumping plant provided sufficient water for all purposes, and was distributed by gravity to camps, corrals, mixers and along the flume bench for sprinkling the concrete. To prevent freezing during the winter months it was necessary to bury all of the main lines that could not be readily drained to a depth of 2 ft.

Handling of Materials

Suitable sand and gravel were uncovered at various points along the work ranging in distance from ½ to 3 miles from the mixer sites. Aggregate was screened at the pit and hauled to the mixer sites in horse-drawn 2-yd. dump wagons or by 2-ton trucks equipped with dump bodies.

The gravel was well graded and was screened to a maximum size of 2½ in. In some cases the most available gravel was found near the bed of the river in which case it was hoisted, by means of a steam

hoist operating gravel cars on an industrial track, to the road above the flume bench and then distributed by wagons and trucks to the mixer sites.

Portland cement delivered to the nearest railway station was hauled to the mixer sites in 2-ton trucks, where it was stored until used.

Reinforcing steel was purchased in sizes and lengths that would cut with minimum waste. This steel was hauled by truck to a central yard at the work where it was cut and bent to proper lengths and shapes. The bending of this steel was materially expedited by building a rigid bench on which templets of the proper dimensions were fixed and around which the steel was bent to required shapes. After some experience, two men could cut and bend from 350 to 400 transverse bars per day. In placing this steel in the forms crews were able to place two or three times as much steel by using tying tools and tie wire of proper lengths instead of ordinary pliers and straight wire.

As there was not sufficient room on the flume bench for a construction or operating road, it was necessary to build a construction road on the hillside above the flume. While the road was located as near the flume as possible it was in some cases a half mile distant requiring spur roads to be built to the mixer sites.

Mixing and Placing Concrete

The location of the mixing plants and the transporting of the concrete from the mixers to the forms was controlled largely by local conditions but usually one of the three following described methods was employed:

1. Where the construction road was parallel to and only a short distance from the flume bench and where the flume bench was too narrow to operate a team and wagon, the mixer plants were located on the construction road at ½-mile intervals. Concrete from these plants was hauled along the road in one-horse ⅜-yd. carts to a point below which the flume building was then in progress. The concrete was then spouted from the road to a hopper on the flume bench and distributed from this hopper by hand-carts operated on runways laid on top of the flume forms. The chutes from the road to the flume bench were spaced at 600-ft. intervals requiring the concrete to be distributed by hand a maximum distance of 300 ft. either side of the chute.

2. Where the flume bench was wide enough to permit the operation of teams and wagon alongside the flume the mixer plants were located at ½-mile intervals. A batch of concrete was spouted from the mixer into three one-man size concrete carts. These carts were pushed onto a flat-top wagon and hauled along the flume bench to the forms. As the wagon bed had been built to approximately the same elevation as the flume forms the carts were easily pushed from the wagon onto the runway laid on the forms and the concrete deposited at any desired point. This method was the most economical as it was more flexible than the first and third method and did not require forms to be left in place to act only as a support for the runway as was often the case in the first and third method.

3. Where the construction road could not be brought closely parallel to the flume bench, nor operating roads be maintained thereon, mixer sites were located on the hillside above the flume at approximately 900-ft. intervals and connected to the main road by spurs. The concrete was spouted directly from the mixer to a hopper on the forms from which point it was distributed along the flume by hand-carts a maximum distance of 450 ft. each way from the hopper. Although in many cases this was the only practical method to follow, the cost was somewhat higher than either of the other two methods.

Drainage was provided to prevent surface water or leakage from the flume collecting behind the flume and soaking into the foundation. This was accomplished by laying a 4-in. open joint vitrified tile pipe parallel to the flume, slightly below and on the same slope as the floor. Relief drains were provided every 100 ft. by laying a 4-in. bell-and-spigot tile pipe from the drainage line at right angles and under the floor of the flume discharging over the side of the bench.

The procedure in building this flume after the grading was completed and the drainage system installed was as follows:

The outside forms were set up to line and grade, the reinforcing steel placed and then the inside forms were set up and all forms braced. The floor was poured first and allowed to get a partial set before the side walls were poured. In warm weather the forms were allowed to stay in place one day and in cold weather from two to three days before they were stripped and moved ahead. After the forms were stripped the concrete was sprinkled for ten days to cure it. During freezing weather the concrete was covered and protected from freezing with artificial heat.

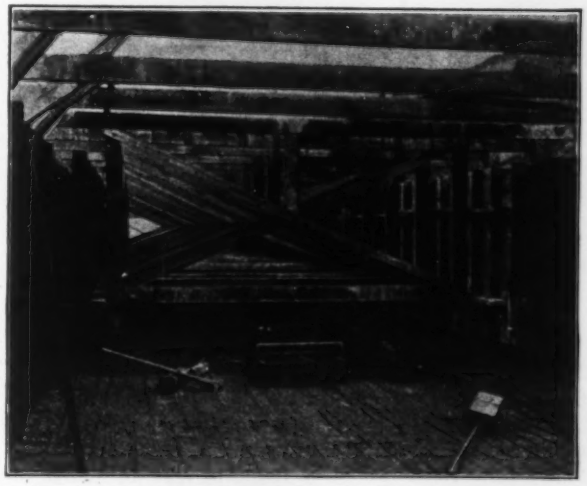


FIG. 5. METHOD OF HANGING FORMS FOR RE-USABLE PANELS FOR NO-JOINT FLUME

The only advantage that the bell-and-spigot type of flume has over the other types is that it requires a less amount of temperature steel, which advantage at the present cost of steel and labor is offset by the greater amount of labor required. The disadvantages are as follows:

1. It is impossible at a reasonable cost to build expansion and contraction joints that are sufficiently water-tight.
2. The leakage from imperfect joints, unless the flume is built on a very solid foundation, is likely to cause settlement which in turn increases the leakage and finally leads to failure of the flume.
3. In climates where the foundation of the flume freezes during the winter months the spigot sections are likely to heave, throwing such sections out of grade and opening the joints so that when the flume is refilled serious leakage occurs.
4. The continuity of the forms being broken at each joint, it is difficult to hold the forms sufficiently rigid to maintain an even thickness of concrete in the side walls.
5. The progress is greatly retarded on account of erecting the forms for the contraction joints, and double the length of forms are required in a type where the concrete is poured in alternate sections as in one which can be poured continuously.
6. The maintenance of this flume will be considably higher than any of the other types.

Of this type a length of 2¼ miles has been built and it is believed that it will give good service for its expected useful life.

Concrete Flume Without Joints

As the contraction joints were directly responsible for all the objections arising in connection with the bell-and-spigot flume, a flume without joints was designed.

To build such a flume sufficient longitudinal reinforcement must be provided to prevent contraction cracks of sufficient size to permit water to escape. It was computed that with a temperature variation of 70 deg. F. and with sufficient reinforcing steel to force the concrete to crack at 5-ft. intervals the cracks would be so small as not to be objectionable.

The temperature in southern Idaho ranges from about

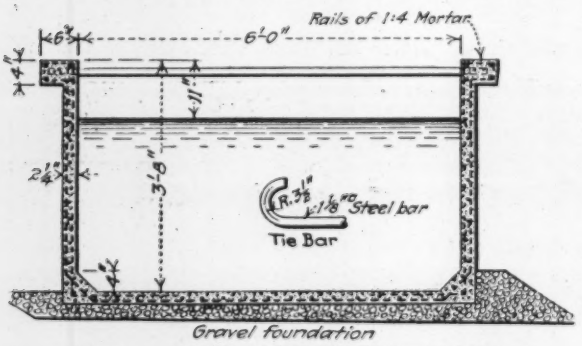


FIG. 6. DETAILS OF THE GUNITE FLUME

Long. Reinf. = ⅝ in. sq. rods, 4 in. c. to c.
Transv. Reinf. = ¼ in. sq. rods, 10 and 20 in. c. to c.

20 deg. F. below zero to 120 deg. F. above; therefore flumes constructed during the summer months would be subjected to a temperature variation of 140 deg. and would require a prohibitive amount of temperature steel, unless some means could be found to take advantage of a lower temperature variation. This was accomplished by building the flume in sections 300 ft. long whenever the temperature was above 50 deg. and leaving 18 in. joints between sections. The longitudinal steel from adjacent sections was allowed to extend unrestrained across the joint permitting the flume to move freely in each direction. During the fall months when the temperature dropped to between 40 and 50 deg. F. these joints were poured bonding all the longitudinal steel together. This method had the same effect as pouring all of the flume at the lower temperature. It was estimated that the length of the sections that could be poured in the summer months would be the length of flume that the longitudinal steel could drag along its foundation without failure, assuming that the flume would be anchored at and pull an equal distance each side of the center point. In the case of curves with a large central angle the joints were placed not more than 150 ft. each side of the curve.

Using ⅝-in. square twisted steel bars with an elastic limit of 55,000 lb. per sq.in., computations showed that 0.65 per cent of steel was necessary to force the concrete to crack at 6-ft. intervals and when the temperature variation was 70 deg. the cracks would be 0.0327 in. in width. However, the cracks would only be 0.013 in. in width at the lowest temperature at which water would be carried in the flume. Using ½-in. bars in the floor, 0.43 per cent of steel was required to force cracks at the same intervals with the same range of temperature. The side walls were designed as vertical cantilevers and required no cross-ties.

The side-wall forms a right angle at the point it joins the floor; while in the bell-and-spigot type of flume, a fillet is used as an extra factor of safety. The fillet can be safely omitted as the flume is amply strong without it and it adds a decidedly objectionable complication in the forms, particularly on curves.

For all practicable purposes this flume is watertight, and no tile drain system is required. Cross-drains under the flume of 12-in. tile or 12-in. square concrete boxes were provided at intervals to carry off storm water.

Importance of Formwork

Previous experience showed plainly that the progress and cost of the concrete in this class of work depended largely on the forms. Therefore, a new type of re-usable forms in 16-ft. panels was developed using a minimum amount of material and offering possibilities of rapid erection. On account of the leakage caused by form wires and the time and trouble required in placing them, this method of tying the forms together was abandoned in favor of the use of steel pins which could be removed from the concrete when the forms were taken down. The holes resulting from the use of these pins were plugged with grout as soon as the pins were removed. These forms were designed with an idea of eliminating as much work as possible and at the same time having a set of forms which would not spread when in place. With this in mind, bolts, coupling pins and other labor-saving mechanical devices were used wherever possible. These forms proved to be entirely satisfactory and their use lowered form costs 40 per cent.

Following the installation of the cross drainage, two 3 x 6-in. planks, one on either side and parallel to the center line, were placed at such distances from the center line that they would come directly under the outside of the forms. These planks were placed to exact grade of the foundation and a straight edge was then used with its ends resting on them to level off the subgrade.

The procedure in the erection of the forms and the placing of the steel was as follows: The outside panels together with the posts and templets were set up and held together with the top cross-braces. The steel was placed and the inside panels and posts were suspended from the top cross-beams. The inside templets were placed on the brackets and all securely held in place by the inside struts and braces. Fig. 5 shows the forms and reinforcing steel in position.

After the forms were set up it was only necessary to put a bulkhead in the forms at the end of each day's run, the usual method in this connection being to run as much floor with 4 in. of the side walls as could be poured in the forenoon. The bulkheads were then placed across the flume at this point and in the afternoon the side walls were poured.

It was found when the joints were poured that there was enough variation in the temperature during the time that it took the concrete to set to cause a movement of the steel in the joints, thus tending to break the bond between the steel and the concrete. To overcome this tendency an oxy-acetylene welding outfit was used to weld the reinforcing bars in the joints before the concrete was poured, thus making the reinforcement continuous and preventing any movement due to contraction.

During the warmer weather forms could be removed

from the concrete the day following pouring but as the weather grew colder it was necessary to leave these forms in place for a longer period. The concrete was protected from freezing by covering the structure with burlap and by keeping fires on the inside of the flume. The most efficient kind of stove and the most easily fired was a 15-in. corrugated pipe 10 ft. long. One of these stoves would accommodate long sticks of wood, which saved labor and at the same time produced as much heat as several ordinary sheet-iron stoves.

An average day's work was about 125 lin.ft. of this size flume, containing 0.425 cu.yd. per lin.ft.

Approximately 2 miles of this type of flume have been built and it has proved entirely satisfactory. It has overcome all the objectionable features mentioned in connection with the bell-and-spigot type, and to date has developed no weak point.

All Gunite Flume

The gunite flume is built without joints and is designed with sufficient longitudinal temperature steel to force the gunite to crack at 24-in. intervals. It was observed after this flume had been built for some time that instead of cracking at 24-in. intervals, a very fine hair crack appeared every 10 in. at the point the transverse steel reduced the gunite section. The walls of the flume are designed as simple vertical beams and the load from the water pressure is transmitted from these walls to the floor and to a coping or rail, reinforced as a continuous beam, built on top of each wall. Tie bars across the top of the flume at 8-ft. intervals connected the copings. The flume was built on a 6-in. gravel foundation which provided ample drainage for any possible leakage from the flume and also the ordinary surface drainage, except at the crossing of small draws where additional tile drains were installed to carry off surface water.

The aggregate used in the gunite was 1 part cement and 4 parts sand. It was found that when this mix was shot onto the forms there was a rebound amounting to about 25 per cent of the sand; the amount of the rebound depending largely upon how well the sand was graded and more particularly upon the percentage of small particles. This rebound was found to contain practically no cement.

The hydraulic properties of a gunite flume are the same as those for other flumes of like section except for the value of n in Kutters' coefficient. It was assumed that for the side walls, which were formed on the inside, the value of n would be 0.014 which is the same value as for concrete with a like finish, but that for the bottom of the flume which was untroweled gunite, the value of n would be 0.018, giving approximately an average value for the flume of n equal to 0.016. An attempt was made to reduce the friction loss in the floor by troweling the surface, but this was abandoned as it was found that this troweling was injurious to the gunite to the extent of reducing it to the density of concrete.

The principal equipment used was two air compressors, two cement guns of the N-2 type and the necessary forms. The compressors had a capacity of 240 cu.ft. of air at 50 lb. pressure. They were portable and driven by direct-connected internal-combustion oil engines, and were located along the flume at 700-ft. intervals. The air was conducted from the compressors about 350 ft. in both directions. The forms were reusable, built of shiplap in panel lengths of 14 ft. and were held in place with a system of cross bracing. The bracing and form panels were designed for rapid erection and removal. Fig. 7 shows the alignment which consisted of a series of tangents connected by curves of 50, 75, 100 and 200-ft. radii. Templets cut to the required radii were bolted to the studding on the back side of the form panels to make the forms fit the curves.

Sand was secured from near-by pits and hauled to the flume bench with teams where it was screened by hand over a ½-in. mesh. The sand and cement were mixed

FIG. 7. GUNITE FLUME WITH CURVES OF 50, 75 AND 100 AND 200-FT. RADII

dry by hand before it could be used in the cement guns. The cement gun does not mix the aggregate. It is merely a convenient way of placing after it is mixed.

Placing Reinforcing Steel

Following the preparation of the subgrade the reinforcing steel, which had previously been cut and bent to proper lengths and shapes in a central yard, was placed in position. The inside wall form panels, which were the only forms needed in gunite work, were next erected. These were securely braced and to them were tied the reinforcing steel where it was held to proper shape and grade. The cement guns were at all times kept close to the work as it was our experience that better and faster work could be done with material hose lines not exceeding 50 ft. in length. The side walls were built first, in two layers of from 1 to 1½ in. in thickness. Next and on the same day the floor was placed and finally, after removing the wall forms and allowing the gunite time to set, the forms for the coping were placed and the coping poured using the rebound mixed with cement in a proportion of 1 part cement to 4 parts sand. Considerable trouble was experienced in obtaining a good job in the floor as the rebound, having no avenue of escape, would tend to collect in piles which, if covered with gunite, would leave weak spots. It is therefore necessary to shut down the machines at frequent intervals and clear away the rebound, a procedure which added materially to the cost.

The forms were left in place until they could be removed without injury to the gunite. In warm weather this requires only five or six hours, but during cold weather from one to two days. This flume was built during the early spring when strong winds prevailed, and was covered with burlap on which water was sprinkled for ten days to prevent the gunite from drying out too rapidly.

An average day's run with two machines, after the men became familiar with the operation of the cement

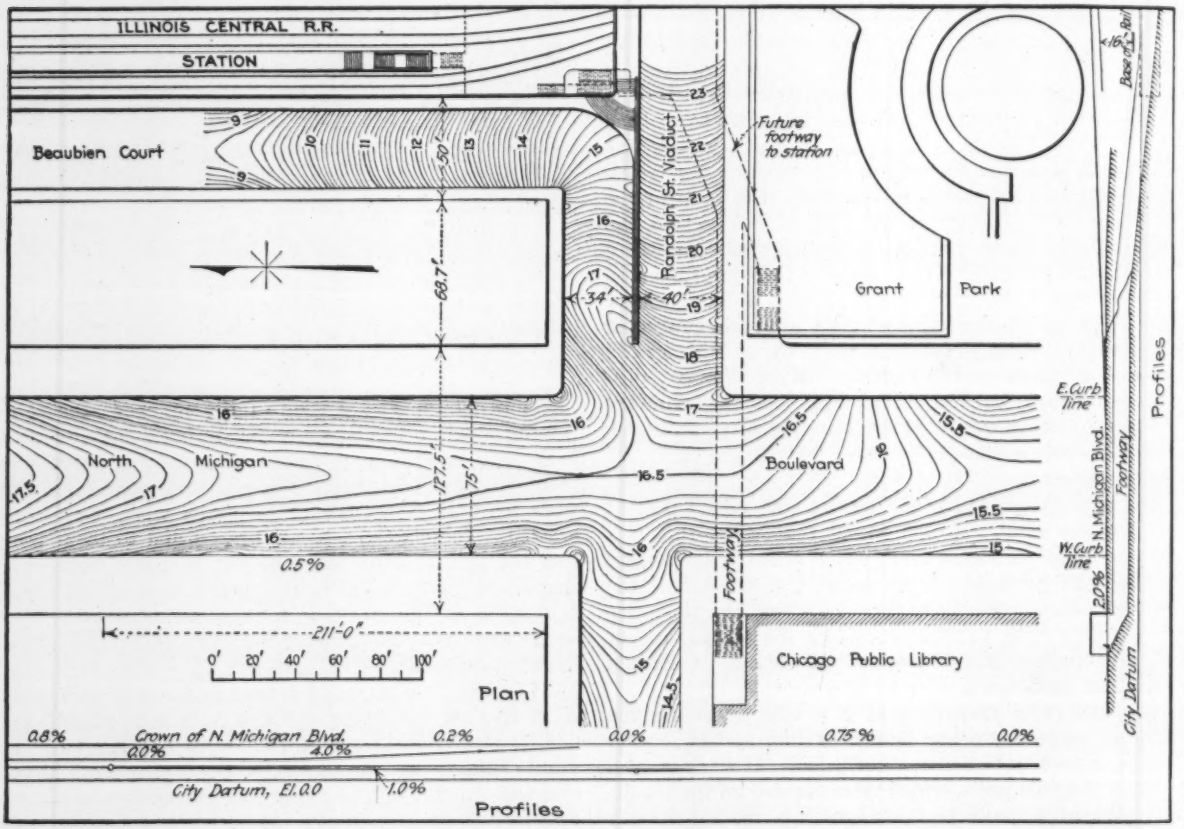
guns, consisted of 160 lin.ft. of completed flume, which is equivalent to 15 cu.yd. of gunite per day of 8 hours for two machines.

This flume, after being in operation for 3 years, has demonstrated its merit as a type to be built on a foundation which will not stand up under any leakage from the flume. Although the floor and sides are only 2¼ in. in thickness, the flume is, for all practical purposes, watertight and has required no maintenance since its construction. There were, however, some disadvantages developed. The coping wall, which had to be poured after the gunite was placed, materially reduced the rate at which the flume could be built. Also the crossties retarded and increased the cost of the form work. Another disadvantage is the increased water area required for a given slope, necessitated by the rough gunite floor. To overcome these objectionable features another type was designed having a concrete floor poured in place and side walls of gunite reinforced as cantilevers.

[*Section II on concrete-and-gunite and semi-precast concrete flumes will appear in an early issue.*]

Contour Map of Street Intersection

IN ORDER to explain graphically to various municipal authorities a proposed rearrangement of grades at a Chicago street intersection, due to the construction of a footway under Michigan Ave., the Illinois Central R.R. had recourse to a contour map having intervals of 0.1 ft., as shown in the accompanying drawing. Extremely heavy automobile traffic in Michigan Ave. is crossed by traffic to and from the Randolph St. suburban station. From this intersection Michigan Ave. is level toward the south and rises toward the north on a grade which begins at 0.5 per cent and gradually increases to 2 per cent. Randolph St. is level toward the west, but toward the east it divides into two inclines of 4 per cent, one descending to Beaubien Court (for teams) and the other ascending as the approach to the Randolph St. viaduct.



COMPLICATED GRADES AT A CHICAGO STREET INTERSECTION

In planning the reconstruction of the Randolph St. station, it was to the interest of the railway company to raise this viaduct as much as possible, in order to avoid the depression of tracks under the approach. For this reason it was desired to raise the east side of Michigan Ave. about 21 in. above the former grade. With the contour map it was possible to show clearly that such a raise at the southeast curb corner would not be objectionable to the Michigan Ave. traffic. This arrangement was carried out with modifications in constructing the footway shown on the plan (*Engineering News-Record*, Oct. 21, 1920, p. 798).

The contour map was prepared by C. H. Mottier, office engineer, directed by D. J. Brumley, chief engineer, Chicago Terminal Improvement, Illinois Central R. R.

Wood Preserving in 1920

More than two billion board feet of timber was treated in 112 active pressure wood-preserving plants in 1920 in the United States. According to the Service Bureau of the American Wood Preservers' Association 25,000 tons of zinc chloride and 69,000,000 gal. of creosote oil were used.

Rapid Renewal of Turntables at Engine Terminals

Different Methods of Two Railways in Locating and Placing New Table, Removing Old One, and Handling Masonry

IN REPLACING old turntables with others of larger diameter there is the difficult problem of reducing to a minimum the actual time between putting the old one out of service and getting the new one into service, since interruption to roundhouse movements is a serious matter at busy engine terminals. Two very different methods devised by two railways for work of this kind are described below, a difference of special interest being that in one case the old and new tables were made eccentric while in the other case they were concentric. Reference may be made also to the methods of placing a new 100-ft. table for the Missouri, Kansas & Texas Ry. at Oklahoma City, Okla., as described in *Engineering News-Record* of Aug. 18, p. 293.

Gulf, Mobile & Northern Ry.

With the introduction of new large locomotives on the Gulf, Mobile & Northern Ry. it was necessary to replace a 60-ft. turntable with a new 80-ft. turntable on the same location at New Albany, Miss., in 1920. At the time of replacement a sudden increase in traffic made it impracticable to put the old table out of service and there was no ground available for a temporary Y track.

Eccentric location of the new table solved the problem of replacement under these conditions, its center being placed as close as possible to that of the old table so that the new circle wall would fall entirely outside of the old one. This permitted building the new center foundation and the new circle wall and footing without interfering with the old work. The two centers were 7½ ft. apart and in line with the main lead into the roundhouse. With the new table in place it was necessary to make a slight bend in the other radial tracks, but this does not interfere seriously with the operation and will be remedied when the roundhouse is rebuilt.

When all was ready for changing the turntables, the old table was lifted out bodily by the railway company's 75-ton wrecking crane. This machine was used also to break up and remove the old concrete wall and foundations, some of the masses weighing about 15 tons. The old center block, which did not rest on piling, was lifted out in one piece, the casting being left on it for attaching the crane hook. From the main lead track, extended on cribbing into the pit to within 16 ft. of the new center, the new table was swung into position, the cribbing being then removed to allow the table to revolve. After the table was in operation the interior of the pit was cleaned out and paved with concrete.

Everything possible was done in advance and two days were allowed for making the change. The old table turned its last engine at 8 a.m. one day and the new table turned its first engine at 6 p.m. the next day. No work was done at night, so that the actual time consumed was only about 21 hours. This work was planned and directed by L. W. Duffee, then chief engineer.

In replacing a 70-ft. deck girder turntable with an 80-ft. through girder turntable on the International & Great Northern Ry. at Palestine, Tex., the same center was used, making the new and old pits concentric. The change of tables was made in very short time, the new table being ready for service within 16 hours after the old table had been put out of service. Engine movements to and from the roundhouse were discontinued for only 18 hours.

As the first step, the new concrete circle wall and pit floor extension was built about 5 ft. outside of the old wall, all radial tracks being maintained in service. Track extensions were made of old rails, well reinforced, which when fitted to the rails of the old table would rest upon the new wall. The wood curbing was next removed from the old wall, the rails in radial tracks were cut back to the new line, and the track extensions were placed on the table, so that the 70-ft. turntable operated in the 80-ft. pit.

A precast concrete block 5 ft. in diameter and 2 ft. thick, with holes for anchor bolts and electric conduit, was placed in the old center foundation to give the required increase in height. Four small pipes in this block provided for drilling holes into the old foundation. In the meantime, the old circle wall was broken down by small charges of dynamite and the new circle rail was placed. Preliminary work was completed by the assembling of the new table, with deck and rails laid, the table being then placed and carefully centered on a flat car.

This car was run onto the old table, which was set at right angles from the position for its removal. The track extensions of the old table were then removed to make room for placing framed bents which had been prepared to support the ends of the new table when jacked up clear of the car. Then the old table was swung 90 deg., the empty car was removed, and the table was hauled out of the pit on an inclined skidway.

The old concrete center foundation was then cut down and leveled to the required elevation to receive the precast concrete block, which was lowered into the pit, slung from the underside of the new table and set in place, melted sulphur being used for a thin grouting. Holes were drilled into the old foundation through the pipes mentioned above, steel dowel pins were then placed and the holes filled with sulphur, thus securely anchoring the block to the old foundation. As soon as the center castings were in position the new table was lowered into the pit by the locomotive derrick and was ready for operation.

This work was done by railway forces under the supervision of F. S. Schwinn, chief engineer; R. E. Caudle, division engineer, directed the work in the field.

English Articulated Trains

An articulated train put in service recently by the Great Northern Ry., England, consists of five cars mounted on six four-wheel trucks, there being a truck at each end and one under each of the short vestibuled connections between the cars. A 40-ft. kitchen car is at the middle of the train with a first class 45-ft. dining car and a 55-ft. coach at one end and a third class dining car and coach at the other end. All cooking is done by electricity. This train is for a four-hour run between London and Leeds, making a round trip daily. The purpose of the design is to reduce dead weight. Thus, the train is 246 ft. long, accommodates 128 passengers and weighs 118 tons on twelve axles. The ordinary train previously used consisted of four cars 60 and 65 ft. long, of which the two dining cars (with kitchen in one car) had six-wheel trucks. This older train was 256 ft. long, accommodated only 110 passengers and weighed 139 tons on twenty axles.

Nashville Concrete Bridges Show Serious Deterioration

Rusting of Reinforcement in Columns, Chords and Railing Causes Trouble in Two 12-Year-Old Concrete Viaducts and Trusses—Limestone Screenings Used in Concrete

REINFORCED-CONCRETE columns, truss chords and railings, parts of two bridges at Nashville, Tenn., are in rather serious condition as a result of the corrosion of the steel reinforcement and the consequent spalling off of large pieces of the covering concrete. While the strength of the structures is not yet so affected as to cause immediate concern, several engineers who have inspected the bridges feel that a continuance of the action would soon bring about a condition where the safety might be questioned. So far no thorough investigation into the causes of the trouble has been made, although the city engineer has repeatedly endeavored to interest the city council of Nashville in such an investigation. The statement of the condition of the bridges given herewith is a result of reports and investigations by several engineers, most of whom are noted in the article.

ELEVATION OF SPARKMAN STREET BRIDGE ACROSS THE CUMBERLAND RIVER AT NASHVILLE, TENN.
(Reprinted from *Engineering News*, Feb. 25, 1909)

The two bridges in question were known when built as the Sparkman St. bridge and the Jefferson St. bridge, although the former is now known as the McGavock St. bridge. They are both over the Cumberland River with approaches over the low lands on either side. The Sparkman St. bridge crosses the river just above the foot of Broad St., in the central part of the city, and the Jefferson St. bridge crosses at a point about three-quarters of a mile below the former. In both bridges the channel spans are steel trusses on concrete piers, and in both of them a part of the approach is earth embankment on each side of the river supplemented by long reinforced-concrete viaducts of trestle bent type except where the Sparkman St. viaduct crosses several tracks of the Tennessee Central R.R. Here heavy concrete trusses carry the approach over the tracks. The Sparkman St. Bridge was described in detail in *Engineering News* of Feb. 25, 1909, p. 199, and Nov. 25, 1909, p. 570. Both bridges were completed in 1910 by Davidson County.

About 1912 the county authorities requested the city authorities to assume control of the bridges and to undertake their maintenance. The city did reluctantly take the bridges over and has since been responsible for them. The city engineering department, however, was not consulted when the bridges were designed nor during their erection and had no voice in the location or design of either structure. They were built by the Cumberland River Bridge Commission, with Howard M. Jones as chief engineer and with the Foster-Creighton-Gould Co. of Nashville, Tenn., as contractors.

The design of the two bridges is practically identical, that is the same type of structure and identical specifications were used, although some of the detail sizes are different. It is in the approaches where the current difficulty is being experienced. These approaches as stated above, are of two types—the concrete truss type and the viaduct approach. These concrete trusses vary in span from 85 to 105 ft. and are of the bow-string curved upper chord type, with vertical posts but no cross braces. The lower chord, which varies from 18 x 30 in. in section in the shorter spans to 18 x 36 in. in the longer, is an important part of the structure as it acts as a tie to take the horizontal components of the end trust. About one-tenth of its area is strengthened by rods and the concrete acts only to protect the steel. The top chord follows practically the line of pressure of the equilibrium polygon resultant from the dead load and is practically all in compression. For dead-load only the pressure is uniformly distributed over the cross-section and has a maximum of 394 lb. per square inch. If in addition to this there is a live-load of 80 lb. per square foot over the roadway the unit stress will be increased to 512 lb. per square inch. A typical lower chord, 36 x 18 in. in section, has eighteen 2¼-in. rods. A typical upper chord, 36 x 40 in. in cross-section, has eight ¼-in. rods with a lacing of ⅜-in. rods 18 in. center to center.

The viaduct, 1,060 ft. long in the Sparkman St. Bridge, is of the trestle type, ranging from 18 to 50 ft. high. It is mainly in 30-ft. spans supported by three transverse columns 24 x 24 in. for the higher part and 20 x 24 in. for the lower. The columns are grouped in bents of six columns, joined by 10 x 15 in. struts and are reinforced with straight rods in the corners. There are service staircases made of sloping reinforced-concrete stringers between sets of small columns erected alongside the viaduct.

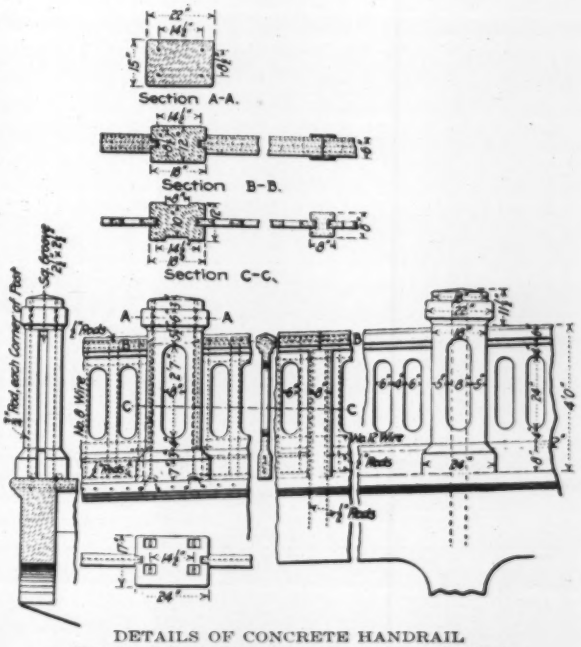
Regarding the present condition of the bridges, W. W. Southgate, city engineer of Nashville, writes as follows: "During the winter of 1913-14 we had a prolonged spell of very cold weather, the thermometer dropping below zero for several days. Very soon after that cold snap one of the main piers of the viaduct approach of the Sparkman St. bridge where the viaduct crosses Second Ave. on a steel plate-girder bridge, revealed a large, vertical crack extending through the coping and several feet down into the main pier. Upon close examination it was found that not only had this main supporting pier spread open vertically, but that the split also extended up through the pedestal on top of the coping supporting the large main reinforced-concrete floor-beam at the junction with the cantilever arm supporting the sidewalk, also splitting the big floor beams.

"This department took steps immediately to repair this dangerous defect and, though it was a rather complex piece of bridge surgery, it was successfully accom-

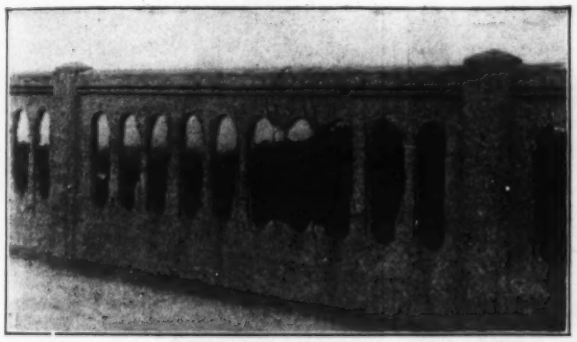
plished and is all right today. The trouble was caused by insufficient allowance for expansion and contraction.

"This department has had since that time to make several similar repairs to several of the main supporting piers of the viaduct on both the Sparkman St. bridge and the Jefferson St. bridge, due to the same oversight in not providing sufficient expansion and contraction leeway in the design.

"Within about three or four years after the city assumed responsibility for the maintenance of the bridges the reinforced-concrete hand-railings of both structures revealed glaring indications of disintegration of the concrete. These handrailings are rather light and airy looking structures, with oblong slits or openings in the panels. Investigation showed that the structure had been erected under careful supervision and inspection, the cement had been carefully inspected and certified, and the work was conscientiously executed. However limestone screenings were used for the very fine aggregate in the concrete instead of sand. This limestone was the product of a quarry that is badly shot and interspersed with seams of shale. The limestone ledges were of a superior quality of rock but apparently no special precaution had been taken to exclude the shale. As a consequence I am satisfied that the limestone screenings used in the mixing of the concrete of this structure were heavily charged with argillaceous



DETAILS OF CONCRETE HANDRAIL
(Reprinted from *Engineering News*, Nov. 25, 1909)



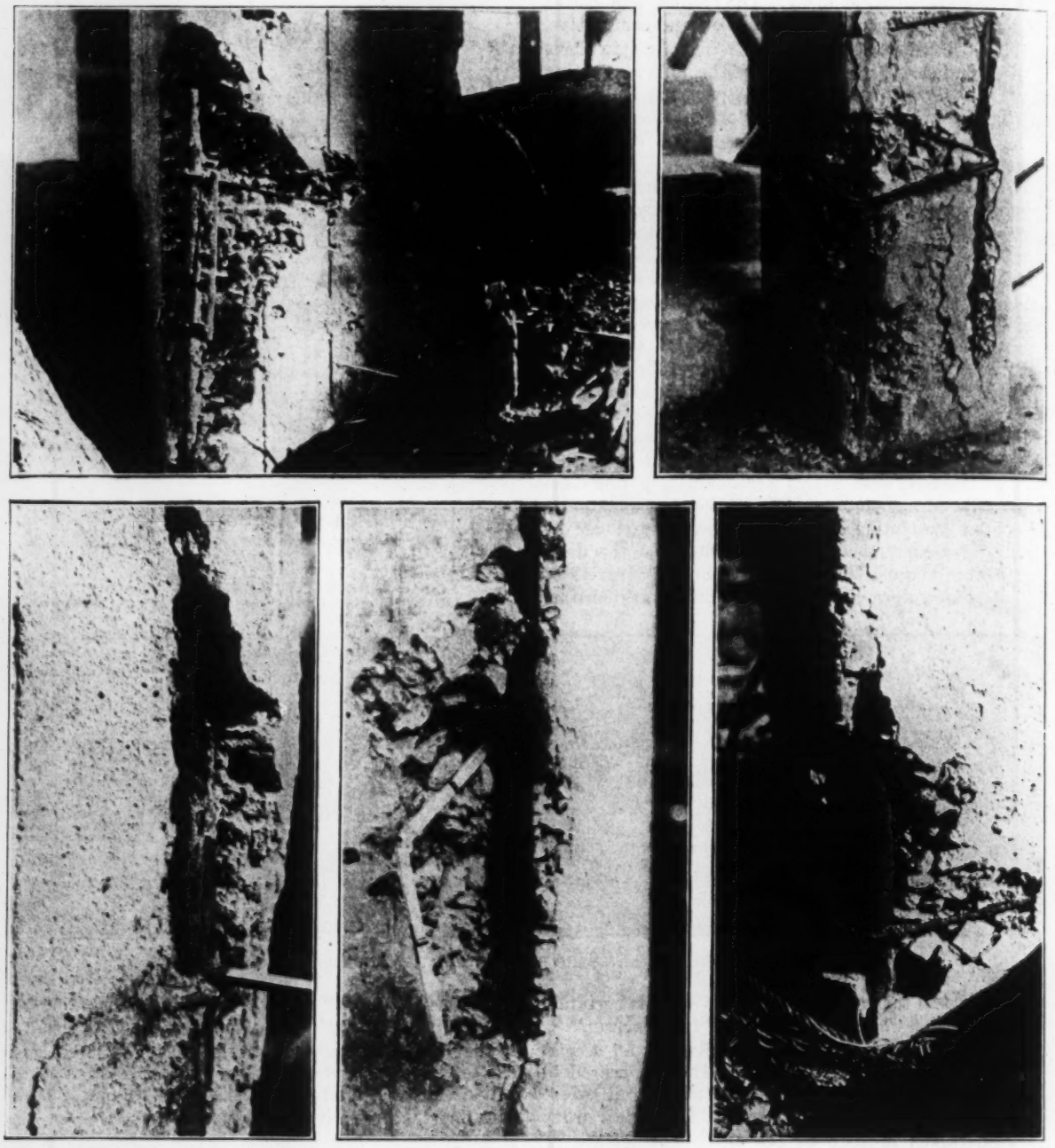
NASHVILLE BRIDGE RAILINGS BEFORE AND AFTER REPAIR WORK

impurities, and that this admixture of shale is certainly one of the causes of disintegration in the concrete."

The detail of the handrailing is given in an accompanying reproduction of a drawing which appeared in *Engineering News*, and the condition of the rail before its repair is also shown just above. The repair work was undertaken in 1916 by the city. The method of repair was very simple. Portable board forms were set up and secured in place on the outside of the handrailing, fitting snugly against it. Where needed, reinforcing steel in the way of wire mesh was inserted in the old handrailing. Then mortar was shot in by a cement gun from the sidewalk of the bridge two panels at a shift. This was allowed to take its initial set. The temporary form outside the handrailing was then taken down and from a suspended scaffold the cement gun finished the outside of the handrailing. The mortar was then troweled to an even surface. The result is shown in one of the views. Some of this work has gone through four severe winters and reveals no signs of disintegration or of checking and cracking, except occasionally where rusting reinforcement is causing cracking in the posts of the hand rail.

Further deterioration of the structure is noted by Mr. Southgate as follows: "An examination of the concrete in the bridge approach reveals that so far disintegration has only occurred where the concrete is exposed to the action of water, that the alternate absorption of moisture and the drying out of the concrete sets up violent stresses therein and produces checks and cracks in the concrete, that the absorption of moisture by the concrete during wintry weather and then freezing causes rapid disintegration. I am further satisfied that the comparatively large percentage of shale in the concrete has upset the physical and probably the chemical equilibrium in the portland cement and has destroyed its strength wherever the concrete is exposed to the weather. A careful examination of the floor-beams and other members of the concrete structure underneath the bridge where these members are completely protected from the effect of the rain and weather, fails to reveal any sign of disintegration. The only sign that I can discover in the concrete is where the latter is exposed to the weather."

Information regarding the condition of the structure that takes a somewhat more serious view of it than does



SOME EXAMPLES OF STEEL CORROSION AND CONCRETE FAILURE IN VIADUCTS AND STAIRWAYS—SPARKMAN STREET AND JEFFERSON STREET BRIDGES

Mr. Southgate's report is given by S. M. McMurray, an engineer of Nashville. Mr. McMurray says:

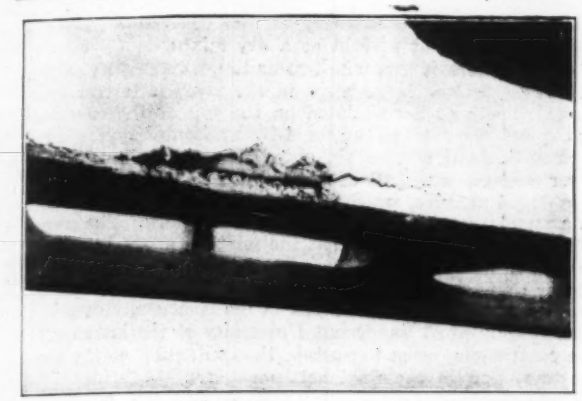
"The disintegration of the exposed concrete, especially in the Sparkman St. bridge, has become more pronounced with the passing years, so that now all of the exposed concrete work has the appearance of a rude mosaic, the surface mortar having all been removed by the elements. In some places whole sections of the handrailing have fallen out and in others, where stairways lead from the bridges to the streets below, slabs of concrete of considerable size have pulled away from the steel reinforcing which is badly rusted and swelled. This is especially noticeable in the columns which support the stairway, where peeling has taken place and where ingress is offered to moisture and the elements. The unexposed part of the concrete, that is the under side of the approaches and the columns supporting them where not directly exposed to the elements, seems to be in fairly good shape."

A further report on the condition of the two bridges has been made at the special request of *Engineering News-Record* by Prof. Robert H. McNeilly of Vanderbilt University. Prof. McNeilly reports as follows:

An inspection of the two bridges in detail reveals the following facts:

SPARKMAN STREET BRIDGE

West approach up to railroad—Main column shows disintegration in only a few places. At one point water stands



EXPOSED RODS IN LOWER CHORD
SPARKMAN STREET TRUSS

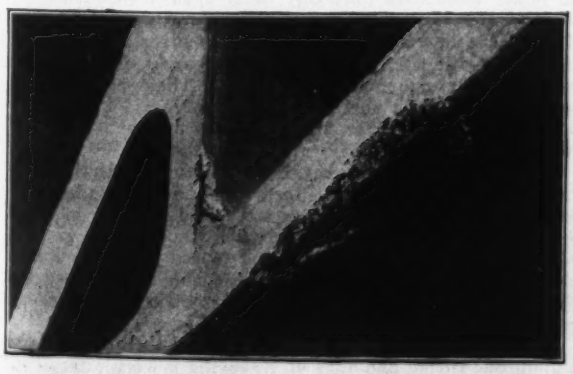
at a column base and the sidewalk has sunken around the base, which leads me to suspect disintegration of the foundation. Near the center of this approach the expansion of the floor system was not properly taken care of and structural strains caused the tops of several columns to split. This was repaired several years ago. Where these columns were tied to adjoining columns the concrete ties show cracks evidently due to structural strains. Upon the floor system, there is frequently evidence of disintegration caused by the expansion of rusting reinforcement.

Bow-string concrete truss over railroad—In two places the concrete has broken away and the heavy lower chord rods (2⅛ in. in diameter) are exposed for a distance of about 18 in. with heavy cracking extending at least 4 ft. along the rod. At one other similar place, the cracking is very pronounced and the condition just as bad. The disintegration takes place in the lower chord below the verticals and seems to be so located due to the water being led down the vertical at this point. In at least 10 per cent of these points below the verticals in these trusses cracks show the beginning of such action. I could not get closer than 15 ft. to these points to inspect them, but I do not believe the trusses are yet in an unsafe condition, as the rods are very large and are heavily bolted through bearing plates at the ends, so they do not depend on the bond with the concrete for their strength.

Subsidiary stairway structures—All the stairway structures on west approach are composed of small members and are in a most serious condition. It appears to me that they will fall down in a few years if something is not done.

East approach—At least 10 per cent of the main 24 x 24 in. columns show exposed steel or badly cracked corners on the columns of the two outside rows where water reaches them. Fully 25 per cent show incipient cracks. Cracks and exposed steel are also evident in the structural part of the floor system.

Handrail—On the entire bridge this is badly disintegrated. Whole panels of the verticals are gone.



ANOTHER BAD PLACE ON THE SPARKMAN STREET
TRUSS OVER RAILROAD TRACKS

Jefferson Street Bridge

West approach—Condition of columns, good. I found no evidence of reinforcement exposed. Condition of floor system about the same as in the Sparkman St. Bridge. I found one place where outer edge of sidewalk had disintegrated and fallen. Near the river after columns were built, some heavy plain concrete walls were built as bumpers around the base of the columns. One of these was badly cracked and one wall about 12 x 50 in. x 30 ft. has broken and fallen entirely down. Where this has occurred one of the columns has been repaired but it is probable that this was broken by some blow or strain.

Stairway—Condition excellent as compared with those of Sparkman St. bridge. I noted only one place where reinforcement was exposed.

East approach—This is in the most serious condition of any part of the two bridges, except the handrails and the stairway structures which do not effect the main viaducts structurally. At least 25 per cent of the columns show exposed steel reinforcement. At least 40 per cent are so badly cracked that one blow of a hammer will expose the steel; both inside and outside the columns are affected. These columns are 24 x 24 in. I measured one place where steel was exposed for 2 ft. and heavy cracking extended 1 ft. below to the ground and 8 ft. above the exposed portion.

EXPOSED STEEL ON STAIRWAY COLUMN

One of the reinforcing rods was calipered. The original diameter was evidently 1¼ in., the present diameter is 1⅛ in., the diameter of the rod with the rust intact about it is 1⅜ in., showing an increase in original diameter of ⅛ in. due to rusting. This approach also shows a bad failure in a cross strut which is hanging by the reinforcement. This is a structural crack, however.

Handrail—Early showed serious disintegration and was filled in solid by gun cement and sand. This has been fairly successful.

Observations on Structures

I regard the important structural members of the Jefferson St. bridge to be in a more serious condition than those of the Sparkman St. bridge although the stairways of the Sparkman St. bridge are structurally in a far worse condition than any portion of the two bridges. (The size of the reinforcement in the concrete truss on the Sparkman St. bridge makes their rusting less serious.)

The columns on the east side of the Jefferson St. bridge sometimes have backwater around them for two or three weeks and a saw-mill with a heavy sawdust pile extends under the viaduct. The water standing on this sawdust pile probably develops organic acids which attack the limestone

of the aggregate, and particularly the limestone screenings used.

There are frequently fogs at Nashville which hang like a blanket over the city night after night and absorb the soft coal smoke of the city with its load of sulphur. This smoke laden fog is often so acid as to cause serious discomfort to one's throat and must contain an appreciable amount of sulphuric acid. This condition is at its worst along the river bank where the fog is densest and receives the smoke of railroads on both river banks. I believe these fogs have in no small degree attacked the limestone screenings and penetrated to the steel, greatly accelerating the corrosion. One sample of the rust when treated with hydrochloric acid gave off unmistakable sulphur fumes.

In the stairway structures the use of 2-in. iron pipe handrails going into concrete posts is especially bad, particularly where the pipes are on an angle going down. These handrails have been attacked and the water probably impregnated with acid has run down the handrail and deposited a load of oxidized iron in the concrete, splitting the columns badly.

There is also a strong possibility of electrolytic action which has been set up with sulphuric acid in the water as a conductor between iron and concrete.

The concrete in these structures was undoubtedly too porous and a greater density could have been gotten by different proportions. Denser concrete would certainly have arrested the disintegration but I believe the vital mistake was the use of the limestone screenings instead of siliceous sand in the mixture. This, however, is an error in judgment which any one might have been led into because the available sand at Nashville is very unsatisfactory and should be carefully washed before being used in reinforced concrete, while the limestone screenings give exceptionally high strength tests in the laboratory.

The safety of the bridges proper is probably not yet affected but the bond between concrete and steel should be carefully renewed in the columns before waterproofing repairs are undertaken.

In connection with the disintegration the following paragraphs from an earlier article on the bridges are of interest.

"Concrete was mixed in two classes, *A* and *B*, *A* concrete of 1:2:4 proportions, and *B*, 1:3:6. Cement limestone dust from $\frac{3}{8}$ in. down and stone from $\frac{3}{8}$ to $1\frac{1}{2}$ in. were the ingredients. This mixture makes an especially white concrete which is of course due to the limestone dust. *A* concrete was used in the 12-in. strip around the outside of the piers and for all the reinforced work. *B* concrete was used in the interior of the piers, retaining walls, and some of the column foundations. The concrete was mixed very wet and frequently the men could stand knee deep in the mass."

Finally, it should be stated, the city engineer, Mr. Southgate, has repeatedly requested that appropriations and provisions be made in the budget for vital and necessary repairs to these bridges, but no money has been available for this purpose until after these reports were written. The city recently appropriated $12,000 for repairs and these are now being made by the city on its own account using the cement gun to protect and build up disintegrated parts.

COMMENTS

Proofs of the foregoing article were submitted to Howard M. Jones, who designed and supervised the bridges. Mr. Jones says that it has been some years since he saw the structures so that he is not in a position to discuss the present appearance. He thinks the following comments are pertinent:

The concrete was not a "sloppy" mixture. This work was done before the day of placing concrete by spouting methods, and the consistency of the concrete was what would be known at present as a dry mixture. On all the reinforced work it was mixed so as to quake slightly in the barrows. On the large piers in the river it is true that water sometimes accumulated on the top of the concrete. The piers were taken up in 4-ft. horizontal layers, and each 4-ft. section was permitted to set before another layer was put on. All of the reinforced work was made of a 1:2:4 mixture, which I believe is generally recognized as a standard concrete mix for reinforced work. The specifications, however, stated that the mixture might be varied so that in no case should the excess of mortar be less than 10 per cent. As a matter of fact, the contractors objected that we were making them put in too rich a mixture, and tests conducted at Vanderbilt University at the instance of the contractors, seem to sustain the contention of the contractors, and in the final settlement for the bridges we allowed them for excess cement put in over and above the 1:2:4 mixture.

I agree with Professor McNeilly, however, that it is quite probable that a siliceous sand would have made a denser concrete had the same amount of sand been used as the screenings that were used. I am also inclined to agree with the professor that most of the trouble is due to the limestone screenings used for the small aggregate. Before permitting the use of limestone screenings an exhaustive research on the subject was conducted, and every text-book which I consulted at that time recommended highly the use of good calcareous material, and invariably stated that it should be as good or better than siliceous sand. I also investigated from current periodicals the use of limestone screenings for small aggregate and found that for important structures all over the United States limestone screenings had been used as a substitute for siliceous sands. The only available local sand was the Cumberland River sand which was full of vegetable matter, and in addition was very fine grained. It had gotten into bad repute as a concrete material and the failure of a number of structures in Nashville had been attributed to the poor quality of the sand. Laboratory tests conducted by me and others showed that briquettes made from this sand did not attain one-half the strength of briquettes made of Ottawa sand, whereas briquettes made from the limestone screenings invariably attained a greater strength than those made of standard Ottawa sand, and frequently doubled the latter. The nearest available point for good siliceous sand was Memphis, Tenn., several hundred miles away, and to have used it would have made the concrete cost at least a dollar per yard more, which, with the appropriation available, we did not think justified its use.

I have within the past few years heard of a number of other cases where difficulty was experienced when limestone screenings were used instead of siliceous sand, which would seem to indicate that laboratory tests, which usually cover short periods, cannot be entirely relied upon to prove the fitness of concrete materials.

I note that the city has appropriated $12,000 to permit the city engineer to make the necessary repairs and I feel quite sure that Mr. Southgate, the city engineer, will rectify all minor difficulties that may occur from time to time if the city grants him the proper appropriations. I think it should be said that no structure, no matter how well designed or built, can be expected to go along from year to year without some maintenance cost. These bridges have been open to traffic now for twelve years, and if they can be properly repaired for $12,000, it seems to be a very low cost of maintenance.

The handrail design in the first instance was undoubtedly too light and airy. In our efforts to make an artistic handrail at a cheap cost, the panels were made only $2\frac{1}{2}$ in. thick with wire reinforcement. The wires could not be kept in place when the concrete was being placed and were forced too close to the surface. When oxidation took place, and through the freezing and thawing of the winters, these thin rails disintegrated.

What Professor McNeilly has to say of the action of the sulphurous smoke and fogs of Nashville is very interesting to me, and seems to be a reasonable explanation of some of the difficulty.

Inspection of Williamsburgh Bridge Cables Shows Wire Well Preserved

TAKING advantage of the rewrapping of the cables of the Williamsburgh bridge over the East River at New York City, now in progress, Edward A. Byrne, chief engineer of the Department of Plant and Structures (bridges) of the city, has been carrying on an examination of the condition of the four 18⅝-in. cables of the structure. On Nov. 30 a party of engineers of the Philadelphia-Camden bridge staff inspected this work under his guidance. The rewrapping is carried on by removing successive lengths of the sheet-steel covering and inner waterproofed-canvas wrapping of the cables, and applying a close circumferential wrapping of No. 9 Norway iron wire galvanized. When a section is laid bare the bundle of wires constituting the cable can be opened up by driving in wedges, and the interior examined to any desired depth.

The sections inspected, which were in the Manhattan land span, had the interspaces between wires fairly filled with slushing oil applied when the cables were constructed (Nov., 1901, to June, 1902), and no signs of corrosion were visible except for a few spots of discoloration on the outer layer of wires. In the main span, Mr. Byrne stated, rust discoloration on the outer wires was found at quite a number of places ranging in width from 2 in. to about 6 in. in spots, and generally occurring at the lower ends of the panels and under the seizing at the lower part of the cables.

The waterproofed canvas wrapping lapped over the suspender bands in downward direction, to shed water, but in the course of time the waterproofing hardened and the motion of the structure then loosened the seal and allowed moisture to enter, after which rusting began in the neighborhood of the bands. No damage has been done to the cables that could be estimated in terms of loss of strength, but the fact that corrosion was going on and that scaling and perforation was destroying the ⅛-in. sheet-steel covering was the motive for the present rewrapping.

Still better conditions have been found in the wire-wrapped cables of the Manhattan and Brooklyn bridges, where opportunity is taken from time to time to expose the interior wires and examine their condition. On the Manhattan bridge the cable bands have given some trouble from slipping. This defect has been remedied by modification of details of the cable bands. When slipping occurred the wrapping wire covering the cable between the bands became disarranged and the cable wire was exposed, making prompt replacement of the bands necessary. In such replacement the band is set back to its proper position and a short section of the wire wrapping to either side of the band is renewed. Before this is done, however, the cable wires are wedged apart and the interior examined. These wires, which are galvanized (those of the Williamsburgh bridge are not galvanized) have in no case shown rust. The same thing applies to the cable wires of the Brooklyn bridge, which also are galvanized; no slipping of bands has occurred on this bridge, but there has been slight movement of the cable posts, which support the trusses, at points where the cables pass below the line of the bottom chord, and where this has occurred the wrapping has been renewed and the wires examined. In every case they have been found in good condition.

The bands on the Manhattan and Williamsburgh bridges are attached directly to the cables and the wrapping is done between the bands. On the Brooklyn Bridge the bands and posts were erected after the wrapping was completed.

The Brooklyn anchorage of the Williamsburgh bridge was also examined by the Philadelphia-Camden engineers and the wires found to be in first-class condition.

The anchorage was free of water and showed evidences of high class maintenance. The condition of the structural steel of the Williamsburgh and Manhattan bridges was also examined, and was found to be surprisingly good. Although repainting has been done at intervals of as much as eight or nine years, no structural parts of either bridge have suffered from rust. Except for thin metal in some railings and floor grills, the steelwork of both structures is considered to be in perfect condition.

Railway Motor Car in Passenger Service

AN EXAMPLE of bus or motor-car equipment for passenger service in place of steam trains or small railways and branch lines is the car shown in the accompanying view, which is now in operation on the Leavenworth & Topeka R.R., a 46½-mile line in Kansas. This car has the frame and driving mechanism of a White 2-ton motor car, but is equipped with a special body and has a four-wheel leading truck and steel flanged tires pressed on the driving wheels in place of the usual solid rubber tires for operating on highways.

MOTOR CAR FOR RAILWAY TRAFFIC

There is seating capacity for 25 passengers, but it is stated that as the car is often crowded it has been proposed to attach a trailer for handling passengers and farm and dairy produce. According to a published statement by O. B. Guffler, vice-president and general manager, the car averages daily receipts of $35 to $40 with an operating cost of $10. This car was adapted to service by the Railway Specialty Co., Atchison, Kans.

Standardization of Filter Press Plates

The standardization of filter press plates is under investigation by a joint committee representing the Association of British Chemical Manufacturers and the British Manufacturers Association (166 Picadilly, London). In a preliminary report the committee states (London *Surveyor*, Nov. 11, 1921, p. 333) that from details of over 800 cast-iron presses which it has collected it was found that although the sizes were many and various yet 67 per cent of the total fall under one of four groups: 18½, 25, 32 and 38 in. These four sizes have therefore been adopted by the committee as standard and manufacturers have been asked to let the committee know whether they will agree to these sizes.

Construction Systematized in Soft Ground Tunnel

Steel Liner Plates Hold Roof With Shallow Cover—Pneumatic Spades Effective—Spoil Trains Run on Schedule—Concrete Deposited Through Chutes Driven Through Ground

WORKING three 8-hr. shifts at two headings, between 700 and 800 ft. of 11½-ft. circular tunnel sewer are being constructed each month under Seven-Mile Road in Highland Park, a suburban section of Detroit, Mich. This consistently good progress is due to a smooth working organization and to excellent results being obtained with pneumatic spades and steel roof plates and by pouring concrete directly into the forms through pipes driven from the street surface into the tunnel every 13½ ft. While none of these devices is new in tunnel construction, they have been operated together in this instance with such good effect that the results in footage are beyond normal.

The Seven-Mile Road sewer is a part of the new main sewer system being constructed by the city of Detroit. The section being considered is 4,750 ft. long and 11½ ft. inside diameter, with a 16-in. concrete lining. The bore is, therefore, 14 ft. 4 in. In excavating, however, the roof is cut about 3 in. high to allow the roof plates to be placed and concreted in without reducing the net thickness of the lining. This makes the volume of excavation per lineal foot about 4 cu. yd. As the tunnel penetrates firm clay, with only occasional sand pockets, the excavation is complicated only by the shallow cover never exceeding 11 ft. Were the tunnel deeper by its own diameter, the excavation could proceed largely without timbering. The thin covering makes it necessary to hold the roof and also the face when this has to be left standing for a few hours. In another respect the shallow cover has been turned into an advantage by driving pipes through it into the tunnel, for pouring the concrete lining.

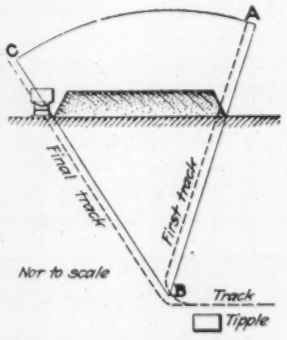


FIG. 1. SPOIL BANK TRACKS SWING RADIALLY

Surface Equipment. — A shaft was sunk about midway of the tunnel and here a car elevator was installed hoisting to an elevated track leading over adjacent spoil tipples. Close to the shaft head-frame are overhead bins feeding to a 1-cu.yd. mixer elevated to discharge into trucks. Alongside the mixer bins and within range of a derrick are stockpiles of concrete aggregates. With its apex at the tipples, the spoil area is fan shaped, with a radius of about 1,400 ft. It is a level tract of low ground which is being filled evenly to a depth of about 4 ft. With cement and power houses, shops and office grouped about, the shaft-head outfit, including the spoil bank, is highly centralized.

Incidentally, the method of building up the spoil bank has interest. On *B* as a center, Fig. 1, the track was swung across the spoil area from *A* to *C*, building up the fill in sloping layers as indicated. By keeping the track always on the original ground and dumping against the fill, overturning of the cars was a very rare accident. The practice of particular interest, however, was the use of a small (about 12 hp.) crawler traction tractor for shifting the track. This proved a most useful device for the purpose.

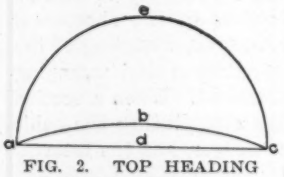


FIG. 2. TOP HEADING EXCAVATED BY ENLARGING SLOT

Excavation.—The excavating methods are noteworthy because of the system for handling spoil cars from two headings with one locomotive, because of the steel lagging support for the roof and because of the use of pneumatic spades to break out the clay. Two headings are worked, one each way from the shaft. The procedure is the same at both.

Excavation begins with a full section top heading to a little below the horizontal diameter of the bore. With the pneumatic spades a slot, *a b c d*, Fig. 2, is cut in the face of the heading. Then, with the spades, the roof *a b c* of the slot is enlarged to full section *a e c*. When about 2 ft. of heading has been excavated a ring of steel roof plates is placed and supported from the bench with trench jacks located as circumstances warrant. These operations are repeated until about 20 ft. of heading has been excavated.

The next operation is to place the needle beam shown by Figs. 3 and 7. This consists of two 12-in. I-beams 22 ft. long bolted together through a wooden filler. The rear end of this beam rests on a 12 x 12-in. post set on the invert of the section previously concreted and the remainder is supported on the bench. The trench jacks

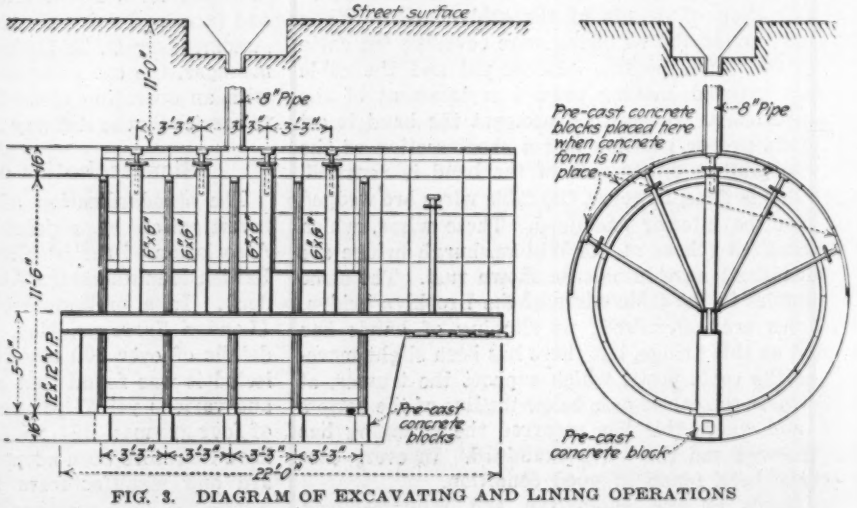


FIG. 3. DIAGRAM OF EXCAVATING AND LINING OPERATIONS

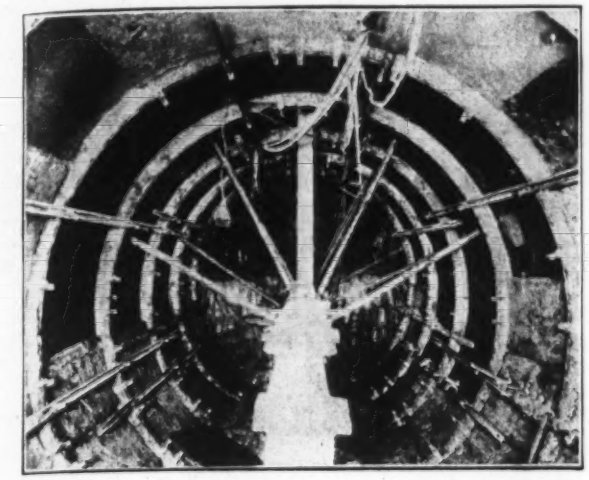


FIG. 5. ROOF PLATE SUPPORTS KEPT CLEAR OF FORM RIBS

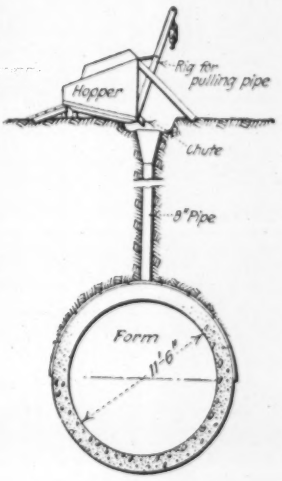
are transferred to the needle beam from which they radiate to the roof plates as indicated by Figs. 5 and 7. These roof plates are 16 x 33 in., flanged for bolting and bent to a radius of 7 ft. 1 in. They are made of No. 16 gage steel and cost about $1 each in place.

With the roof carried by the needle beam and the

FIG. 6. DIAGRAM OF TUNNEL SPOIL TRAIN OPERATION

face bulkheaded as shown by Fig. 5, the bench is excavated by spading down a vertical face as indicated by Fig. 7. As shown by Fig. 3 the bench is excavated just far enough for 13 ft. of invert to be placed. This leaves enough bench to support safely the forward end of the needle beam. The excavation is now ready for the first step in concreting the lining.

Excavation with pneumatic spades carves out and breaks down the clay in blocks and lumps which can be loaded by hand with very little shoveling. These spades have 5 x 9-in. blades, with hexagonal shanks held in pneumatic coal picks by spring retainers. It has been found that spade construction requires particular attention. Forged steel is required to endure the work and, in forging, a special heat treatment is essential. A hard shank and a soft blade endure best. Spades generally break before they are worn out. The excavated material is handled from the faces to the shaft in 1½-cu.yd. cars on 24-in. gage industrial track by a Mercury locomotive. Four-car trains are run, and one locomotive serves both headings. This locomotive, for example, (1) picks up four loaded cars at heading *A*, Fig. 6, hauls them to the shaft, and drops them; (2) picks up four empty cars at the shaft, pushes them to heading *B*, and drops them; (3) picks up four loaded cars at heading *B*, pulls them to the shaft and drops them; (4) picks up four empty cars at the shaft, pushes them to heading *A*, and drops them.



G. 4. OUTFIT FOR CHUTING CONCRETE FROM SURFACE

At the shaft and headings the cars are spotted by hand; sidings provide for the necessary switching and passing movements. To keep the schedule, sixteen cars are necessary, one train at each heading being loaded, one at the shaft being unloaded, and one in route from heading to shaft.

Concreting. — With the bench excavated as indicated by Fig. 3, the invert is concreted. Precast concrete blocks are set on the bottom and on them are erected full-circle form ribs, 3 ft. 3 in. on centers and so located as to come between the radial jacks holding the roof plates. Lagging is placed under the ribs to about the springing line and the invert concrete is poured. Then the floor and tracks can be extended and excavation begun on another section of top heading, while the roof is being concreted. As the roof lagging is placed the radial braces holding the roof plates are replaced by precast concrete blocks inserted between the roof plates and the tops of the ribs as indicated by Fig. 3. The

FIG. 7. ROOF PLATES CARRIED BY RADIALS FROM NEEDLE BEAM

concrete is received through an 8-in. pipe from the surface and, in the tunnel, is led by chutes directly into the forms.

Concrete is conveyed from the central mixing plant by a special 2½-ton truck with a 10-ft. wheel base and pneumatic tires. The truck has two 1-cu.yd. Lee bodies set side by side to dump over the tail. At the depositing point there is a hopper arranged as shown by Fig. 7. The holes are forced down by a sort of churn-drilling operation and are located over the center of each section concreted, as shown by Fig. 4. The concrete is mixed wet and there are no complexities in pouring it or in getting the forms filled and the concrete dense.

Progress.—Working three 8-hr. shifts in each heading there were completed in August 800 ft. in 720 hr. and in September 782 ft. in 652 hr. This is an average for the two months of a little over 9 ft. per shift. Practically a 13½-ft. section is concreted in each heading each 24 hr. This is not the high record for sewer tunnel in clay in Detroit, but it is a remarkably high average for a considerable period.

Construction is under the direction of C. A. Hubbell, city engineer, Detroit, Mich., with J. M. Dorsey superintendent in charge for the contractors, John F. Casey Co., Pittsburgh, Pa. The contract price was $433,152.

Timber Above Summer Water Level Perfectly Preserved

Redwood Grillage Footing of Bridge Pier in Russian River Found Free From Decay After Thirty-Five Years

By C. M. Kurtz

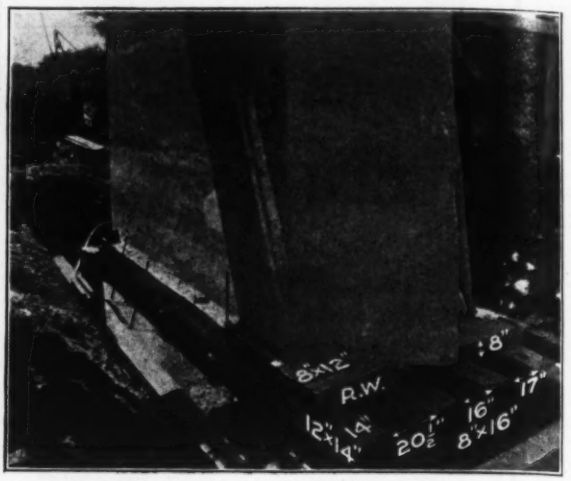
Structural Engineer, Northwestern Pacific R.R., San Francisco

IT IS an old and well established rule in engineering that all portions of piles or timber of a structure's foundation should not extend above the water line.

In some localities, especially cities, the permanence of any given water level can rarely be relied upon. Charles Sooysmith, in *Transactions* Am. Soc. C. E., Vol. 35, page 465, states that in lower New York City the water level at any one point may be materially lowered at any time by pumping from a driven well in the vicinity, or by the constant drainage of some leaking basement or other excavation. As a result of the lowering of the water line, the removal of a building in New York City which had been built on piles driven some 10 or 12 years previously brought to light the seriously decayed condition of the piles, which had not been driven low enough to be kept constantly damp or wet by the ground water.

In constructing the substructures of bridges crossing rivers, the beds of which consist of sand or sand and gravel, it is usually necessary to found the piers upon piles to provide support in the event of underscouring by the stream. That it is not always necessary to have the tops of the foundation piles or all timber-work of such foundations below the extreme low water of the stream was brought to the attention of the writer in August of this year while some alterations were being made to an old pier.

This pier is a member of the substructure of the Northwestern Pacific R. R. Co. bridge crossing the Russian River near Healdsburg, Cal. During the past summer two old spans of this bridge were taken down and two new 97-ft. 6-in. through riveted truss spans erected



BRIDGE PIER GRILLAGE 35 YEARS OLD

in their place. The renewal called for the remodeling of two old concrete piers and the construction of one new pier. The river bed at the site of the crossing is of gravel and sand naturally proportioned for making 1:2:5 concrete. During the summer and autumn the river bed is covered by the stream waters only at the channel near the east or right bank, although the river is temporarily dammed by a low concrete dam a few hundred yards below the bridge to make the water deep enough for bathing and boating purposes in the vicinity.

As the river cannot be depended upon to maintain its channel in its present location, it was decided to extend the concrete of the westerly pier, which supports the end of the west approach trestle and one end of the 97-ft. 6-in. spans, to a lower elevation and so obtain additional security against underscouring that might expose the foundation piles to the action of the current, and later to the drying action of the air. The base of the pier was therefore uncovered, a short sheet-pile cofferdam driven around it, and the sand and gravel of the river bed excavated about 4 ft. below the original bottom of the concrete. At the time of the excavation, the level of the river water was about three feet below the old concrete shaft, as shown in the photograph, taken Aug. 10.

The pier was constructed in August, 1886, and was founded upon a solid timber decking of 8 x 12-in. redwood laid upon 12 x 14-in. redwood sills which capped the piles. Every portion of this timber foundation was found to be in a perfect state of preservation, 35 years after construction. The marks made by the saw with which the decking was trimmed after being spiked in place may be seen plainly, as well as the level of the river water around the piles.

The old timberwork, while well above the various summer levels of the water, had always been covered up with a sufficient quantity of the gravel and sand of the river bed to keep the timber constantly moist. Capillary attraction of moisture from the lowering waters by the sand to the exposed surface of the river bed no-doubt plays an important part in constantly maintaining the damp line so well above the water.

The writer considers this instance of the permanence of timberwork which has not been constantly below the water line as conclusive evidence that it is not necessary in planning foundations to bring the cut-off of the piles

below the extreme low waters of the streams, or the high levels of tidal waters, provided the surrounding backfilling is such that capillary attraction of moisture surfaceward will ensue and will function to maintain a damp section of material above the ground or stream waters.

The pier and its foundation which was brought to light after 35 years of service were constructed under the direction of F. K. Zook, who at the time was chief engineer of the San Francisco & North Pacific R.R. and is now valuation engineer of the Northwestern Pacific R.R. The concrete was machine-mixed, a minimum quantity of water being used, and when placed in the form was well tamped until the mixture assumed a wet appearance. In remodeling, portions of the pier were cut down by air drilling, and the excellence of quality of the concrete as well as the unique reinforcing was revealed. Old cable that had outlived its usefulness in hauling Sutter St. cars in San Francisco was laid in a continuous coil up to within a few feet of the bridge seat. The concrete of the upper portion of the pier was reinforced by short pieces of the cable supplied in generous quantities. All reinforcing uncovered was found to be in excellent preservation. This concrete of 1886 must be listed as one of the earliest examples of reinforced-concrete structures constructed in the United States.

Cofferdams for the Dnieper River Improvement; Russia

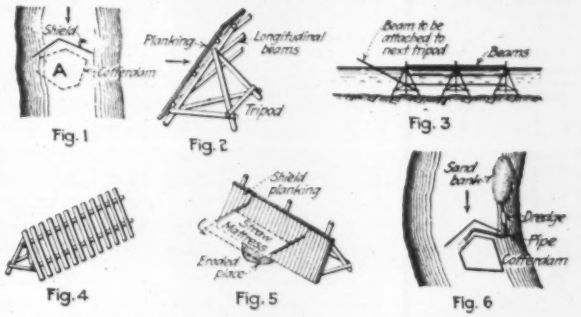
Rock Drilled in the Dry on Site Enclosed in Timber and Sand Cofferdam Protected by Shield on Upstream Side

BY S. N. PETRENKO
Civil Engineer, U. S. Bureau of Standards, Washington, D. C.

FOR channel improvement on the Dnieper River, in Russia, considerable blasting has been done between Kremenchoug and Ekaterinoslav, the work having been in progress for several years before the World War. Drill boats were used formerly but the inconvenience and slowness of the work led to the development of a method of drilling the holes in the dry on areas enclosed within cofferdams. The rocky nature of the river bed was a difficulty in constructing ordinary earth or timber dams, but about 1901 a Russian engineer invented the type of a dam described below and shown in the accompanying drawings.

Assume that a dam is proposed at the area A, Fig. 1. After the spring floods, usually in April, a shield is erected 100 to 200 ft. above the site to divert the current and protect the cofferdam against erosion. This shield is 1,500 to 2,000 ft. long and often occupies more than half of the channel. It consists of braced timber tripods 15 to 50 ft. high, see Fig. 2, set on the river bed and connected by longitudinal beams to carry upright planks. In water over 15 ft. deep three rows of beams are used; one about 3 ft. from the bottom, another above water and the third below water but near enough to the surface to form a working platform in applying the planks.

One end of the bottom beam is attached to the tripod before it is sunk, the other end projecting above water ready for attachment to the next tripod before sinking (see Fig. 3). The face of the shield consists of two layers of 1¼-in. plank spiked to the two upper beams. This planking is placed at two or three places simultaneously and as the openings are narrowed the current, increased to 10 ft. per second or more, tends to erode the sand which covers the rock river bed. If this erosion is not stopped it may cause the tripods to shift downstream until they lodge against a rock projection,



COFFERDAMS FOR ROCK EXCAVATION IN DNIEPER RIVER, RUSSIA

or it ma lead to overturning of part of the shield. To check the erosion it is usual to deposit gravel around the tripod legs by dredges.

An effective but expensive form of protection is to place an open or grated shield above the main shield (see Fig. 4) to break the current and cause sand to be deposited above the main shield. The author has used successfully the method shown in Fig. 5. Two long timbers are attached to the upstream sides of the threatened part of the shield and covered with a mattress of straw, gravel being then placed upon it to cause it to sink like a gate. Work on the cofferdam proceeds at the same time. Its construction is similar to that of the shield but with smaller tripods as the silting below the shield raises the level of the river bed.

Hydraulic dredges then pump sand to fill the space between the shield and the cofferdam. as shown in Fig. 6. A great quantity of sand must be placed as it is very fine and much of it is carried away, even by the weak current below the shield. Protection of threatened spots by deposits of gravel or by shield gratings (Fig. 4) may be necessary. With a top width of 20 ft. for a cofferdam in 20 ft. of water the bottom width will be about 150 ft. Centrifugal pumps unwater the enclosed space in about seven to ten days. The pumping plant must be of sufficient capacity to deal with the leakage, which is very heavy at first but is gradually reduced by silting until one pump working two or three hours daily will keep the bottom dry.

For an area of 200,000 sq.ft. with 10,000 to 20,000 cu.yd. of rock to be removed, the construction of the shield will take about 25 days; dam, 20 days; filling above dam, 20 to 25 days; pumping, 8 days; blasting and rock removal, 80 days. These periods overlap more or less, so that the total will be about 150 days. The cost, including bringing the rock ashore, will be about $100,000. This rock is used for various works on the river. About 50 per cent of the timber is salvaged, and as soon as the timbering is removed the river will soon scour away the deposits of sand.

Exports of Road-Making Equipment

Road-making machinery to the value of $73,108 was exported during September. This shows a slight increase over exports of September of 1920 when the value of such machinery exported was given as $67,169. The figures are those of the Department of Commerce.

Effect of Impact on Pavement Slabs Shown by Tests

U. S. Bureau of Public Roads Gives Results of Research on Concrete and Brick Types To Aid Rational Design of Road Surfaces

TEST results of the effect of impact, simulating that produced by heavy motor vehicles, on a number of types of plain concrete and brick-surfaced pavement slabs have just been announced by the U. S. Bureau of Public Roads as the second part of its research program to secure data on which the rational design of road surfaces may be based. The first research project in this particular field, the measurement of the magnitude and character of the forces delivered to a road by motor truck wheels, was reported in *Engineering News-Record* March 31, 1921, p. 553. The second project, dealt with in this article, is designed to throw light on the behavior of various types of pavement under conditions of heavy motor-vehicle traffic. The third project, the results of which have not yet been reported on, covers an investigation of subgrades. The present investigations, dealing with impact effect on slabs, were conducted at the experimental farm in Arlington, Va., and are the subject of a detailed report by C. A. Hogentogler, highway engineer on the bureau's staff, appearing in the October and November issues of *Public Roads*, the official publication of the bureau. The following extracts from the report summarize the scope of the tests, the methods of conducting them and the general conclusions:

THE IMPACT MACHINE

Fifty-six sections of standard types of pavement, each 7 x 7 ft. in plan, were constructed of plain concrete and of monolithic, semimonolithic, bituminous-filled and grout-filled brick, with cushions of sand and screenings on concrete and macadam bases. The slabs were built with ditches alongside, so that conditions of both wet and dry subgrade could be produced.

The mixes employed were 1:1½:3 for the concrete surfaces and 1:3:6 for the concrete bases. In the monolithic brick sections a ⅜-in., 1:1 dry sand-cement mortar was placed on the green concrete base and leveled for receiving the brick, the joints of which were later grout-filled. In the semimonolithic brick construction a 1-in. bed of dry mortar was laid on the base after it had attained initial set. On the bituminous filled sections the hot filler was poured into the joints from a pouring pot with a spout as soon as the bricks were laid and rolled on the different cushions. Both asphalt and tar-sand fillers were used.

In addition, test beams, 13 in. wide and 7 ft. long, similar in material and thickness to the slabs, and 6 x 12-in. compression test cylinders were made.

Impact Machine

The special machine designed to deliver impact blows to the road slabs, as shown in the illustration, was loaded to represent a 5-ton truck and had 1,800 and 6,000 lb., respectively, for the unsprung and sprung weights. It consisted of a loaded box riding on a 5½-ton spring which, in turn, was supported by a loaded frame or plunger on the bottom of which was a double 2 x 6-in. solid rubber tire. By means of a motor, gears and cam, this plunger or unsprung weight carrying the spring and sprung weight could be lifted and dropped from any height so that the effect produced was identical with that of a truck dropping from one level to another, dropping into a hole or falling to the pavement after striking an obstruction. The plunger was lifted and dropped 6 times per minute.

A specially designed apparatus, supported independent of the impact machine, autographically recorded space-time curves showing the movements of sprung and unsprung weights as well as the vibrations of the slabs under impact blows. These records are the chief source of information on the impact blows.

In addition to the impact tests proper, data were secured on the bearing value of the subgrade soil and its moisture content.

Blows were delivered by the impact machine from various heights of drop from ½ to 2⅜ in. until the slab failed or, if it did not fail, until 6,000 blows had been dealt. Failure was considered to have occurred with the first crack. At the beginning of the test and after 500, 1,000, 1,500, 2,000, 2,500, and 3,000 blows, the height of fall was ½, ½, ⅞, 1¼, 1⅝, 2, and 2⅜ in. respectively. Slabs which did not fail before 3,000 blows were given an additional 3,000 blows at the 2⅜-in. height; and if failure had not occurred as a result of these additional blows the effort to break them was abandoned. If the settlement of the slab after the first 500 blows was equal to or greater than ⅜ in., the drop was not increased for the second 500 blows. A center settlement of this amount generally indicated the beginning of failure.

Test Data Explained

For purposes of comparison the various sections are grouped into four general divisions according to type of constructions as follows: (1) Concrete surfaces; (2) Monolithic brick surfaces; (3) Brick surfaces on concrete bases with 1-in. sand-cement cushions; (4) Brick surfaces on concrete, macadam, and earth bases with sand and screening cushions.

For each group a table has been prepared which gives in concise form the data necessary for the comparison of the several sections comprising the group. (See Tables I to IV.) The height of fall given in these tables is the maximum drop which the slab resisted and corresponds to the forces given in the column headed "Computed resistance." The values given in the column headed "Failure" correspond to the height of fall which was observed to cause failure.

TABLE I. TESTS OF CONCRETE SURFACES

Slab No.	Size, Ft.	Thickness, In.	Mix.	Per Cent Moisture	Bearing Value, Penetration 50 Blows, In.	Computed Resist., Lb.	Height of Fall, In.	Force at Failure, Lb.
18	7x7	2	1:1½:3	....	....	.....	.....	.....
115	7x7	2	1:1½:3	18.4	1.50	7,800	.....	.....
17	7x7	4	1:1½:3	21.2	2.15	14,000	0.204	14,000
113	7x7	4	1:1½:3	18.4	1.15	12,800	0.162	20,400
16	7x7	6	1:1½:3	21.2	1.92	23,700	0.677	26,700
15	14x14	6	1:1½:3	....	....	42,400	3.000	42,400
112	7x7	6	1:1½:3	20.2	2.67	21,600	0.555	26,700
111	14x14	6	1:1½:3	22.7	3.20	28,000 38,900 23,900	0.975 2.410 0.688	31,300 26,700
10	7x7	6	1:3:6	21.2	3.31	21,900	0.575	26,700
124	7x7	6	1:3:6	20.1	2.40	13,200	0.171	20,400
14	7x7	8	1:1½:3	....	2.65	33,000	1.420	34,700
110	7x7	8	1:1½:3	20.4	1.97	39,200	2.480	.....
13	7x7	10	1:1½:3	22.8	2.11	39,200	2.480	.....

Concrete Slabs—The tests of the concrete sections show that slabs of 2-in. thickness are impractical for road surfaces and that slabs 4 in. in thickness can barely resist the static load of the heavier trucks without cracking, so that they surely would fail under impact of such trucks. It is indicated that the 6-in. types are good for a resistance of 21,000 to 24,000 lb. while the 8-in. are good for about 34,000 lb. on subgrades of no less supporting power than those of the test slabs. The indicated resistances of the slabs are: 2-in., 7,800; 4-in., 14,000; 6-in., 24,000; 8-in., 34,000; and 10-in., something over 40,000 lb.

TABLE II. TESTS OF MONOLITHIC BRICK SECTIONS, WITH ½-IN. SAND-CEMENT CUSHION AND 1:3:6 CONCRETE BASE

Slab No.	Base Thickness, In.	Surface: Thickness, In.	Surface: Type	Per Cent Moisture	Bearing Value, Penetr. 50 Blows, In.	Comp. Resist., Lb.	Height of Fall, In.	Force at Failure, Lb.
25	4	4	W.-c. lug	27.6	2.50	31,500	1.27	31,500
128	4	4	W.-c. lug	*	*	*	*	*
121	4	4	Repr.	19.8	1.49	28,300	0.99	31,300
123	4	3½	Vert. fiber	18.3	2.35	21,000	0.53	21,000
21	4	3	W.-c. lug	21.2	2.46	26,900	0.703	26,900
118	4	3	W.-c. lug	18.0	1.84	21,400	0.55	26,700
23	6	4	W.-c. lug	21.0	2.76	39,700	2.58	.....
126	6	4	W.-c. lug	*	*	*	*	*
120	6	4	Repr.	*	*	*	*	*
122	6	3½	Vert. fiber	*	*	*	*	*
20	3	3	W.-c. lug	21.3	2.58	12,000	0.13	20,400
119	3	3	W.-c. lug	18.8	1.68	12,200	0.14	20,400
22	2	4	W.-c. lug	23.5	2.86	22,300	0.50	26,700
129	2	4	W.-c. lug	23.2	3.25	20,400	0.50	20,400
24	1	4	W.-c. lug	23.9	2.48	16,800	0.33	20,400
127	1	4	W.-c. lug	23.0	2.68	18,300	0.40	20,400

* Not tested.

Monolithic Brick—In general the results show that the resistance of monolithic slabs is an uncertain quantity, the uncertainty being caused by the fact that the slab acts as a monolith up to a certain point after which it becomes two independent slabs, when a resistance equal only to the sum of the strengths of the two parts can be expected if top and bottom break at the same instant.

TABLE III. TESTS OF GROUT AND BITUMINOUS FILLED BRICK SURFACES ON CONCRETE BASES AND EITHER 1-IN. SAND-CEMENT OR ½-IN. TAR-MASTIC CUSHIONS

Slab No.	Base Thickness In.	Surface: Thickness, In.	Surface: Type	Per Cent Moisture	Bearing Value, Penet. 50 Blows, In.	Comp. Resist., Lb.	Ht. of Fall, In.	Force at Failure, Lb.
7	6	4	W.-c. lug, g. filled	25.0	3.12	26,400	0.85	31,300
105	6	4	W.-c. lug, g.-filled	19.7	3.62	31,800	1.30	34,700
10	6	3½	Vert. fiber, asph.-filled	25.2	4.40	24,600	0.733	26,700
103	6	3½	Vert. fiber, asph.-filled	19.7	3.71	26,700	0.53	26,700
8	4	4	W.-c. lug, g.-filled	22.6	3.49	18,400	0.39	20,400
106	4	4	W.-c. lug, g.-filled	17.7	1.89	31,600	1.29	31,600
4	4	3½	Vert. fiber, asph. filled	23.9	5.94	13,300	0.18	13,300
2	4	4	W.-c. lug, tar-sand filled	21.2	2.43	14,000	0.21	20,400
116	6	4	W.-c. lug, tar-sand filled	.....	.....	26,800	0.88	26,800

Cushions 1-in. cement-sand, except Nos. 2 and 116, where ½-in. tar-sand was used. Concrete base 1:3:6 in all cases.

Semimonolithic Brick — With one exception, the semimonolithic specimens showed less resistance than in the monolithic. The exception was No. 106 which showed resistance equal to that of the sum of the top and base. In general, however, little relation could be discovered between the resistance and total thickness of the semimonolithic slabs. The resistance is possibly affected by the adhesion between the surface and base.

Brick on Sand and Screening Cushions—In this group are the grout and bituminous-filled brick surfaces with sand and screening cushions laid on concrete and macadam bases. The resistances offered by this last series of slabs were simply those which could be expected from the grouted brick slabs.

TABLE IV. TESTS OF BRICK SURFACES WITH SAND AND SCREENING CUSHIONS AND CONCRETE AND MACADAM BASES

Slab No.	Base Thickness, In.	Cushion	Surface: Thickness, In.	Surface: Type	% Moisture	Bearing Value, Penetration 50 Blows, In.	Comp. Resist., Lb.	Ht. of Fall, In.	Force at Failure, Lb.
104	4	Scrngs.	3½	Vert. fiber, asph. filled	19.4	2.20	15,000	0.25	15,000
9	6	Sand	4	W.-c. lug, g. filled....	22.2	2.43	25,300	0.78	26,700
11	6	Sand	4	W.-c. lug, g. filled....	22.8	1.80	23,900	0.69	26,700
107	6	Sand	4	W.-c. lug, g. filled....	18.0	2.40	29,600	1.10	31,300
114	6	Scrngs.	4	W.-c. lug, g. filled....	18.2	2.19	28,700	1.03	31,300
117	6	Scrngs.	3½	Vert. fiber, asph. filled	17.2	1.53	14,900	0.24	20,400
102	4	Scrngs.	4	W.-c. lug, g. filled....	16.0	1.96	12,800	0.16	20,400
101	6	Sand	3½	Vert. fiber, asph. filled	20.5	3.62	23,400	0.66	23,400
5	6	Sand	3½	Vert. fiber, asph. filled	25.2	3.83	21,000	0.53	26,700
6	4	Sand	3½	Vert. fiber, asph. filled	23.7	3.33	20,400	0.50	20,400
12	4	Sand	4	W.-c. lug, g. filled....	23.5	2.88	14,000	0.21	20,400
125	..	Scrngs.	4	W.-c. lug, g. filled....	19.6	....	14,500	0.23	14,500
1	12	Scrngs.	4	W.-c. lug, g. filled....	23.8	3.32	14,500	0.23	20,400
130	12	Scrngs.	4	W.-c. lug, g. filled....	....	....	.....	.....	.....
3	6	Scrngs.	4	W.-c. lug, g. filled....	25.2	2.98	*	*	*
131	6	Scrngs.	4	W.-c. lug, g. filled....	....	....	.....	.....	.....
108	4	Sand	4	W.-c. lug, g. filled....	17.8	....	13,800	0.20	20,400

Base was 1:3:6 concrete, except for last five sections in table where macadam was used. Cushion 1 in. thick, all cases. * Damaged.

It cannot be seen that the cushioning effect of the sand bed in any way increases the resistance of the pavement. Indications are that the grouted 4-in. brick surfaces are just as strong as the 4-in. concrete slabs. Also, in general, it would appear that the sections with bituminous-filled brick surfaces show less resistance than similar slabs with grout-filled brick.

Test Results Summarized

For the test conditions of size, loading, and support of slabs, as previously described, the following indications are noted:

The resistances shown by 1:1½:3 concrete slabs, 7 ft. square, are very consistent, increasing uniformly with increase in thickness. In slabs 6 in. and more in thickness only primary cracks developed, while 4-in. slabs shattered and punched out at the center. From this it would seem that plain concrete surfaces of 4-in. thickness are inadequate for heavy motor-truck traffic.

The monolithic (brick) slabs in most cases showed less resistance than the 1:1½:3 concrete slabs of the same depth. Failure of the former seemed to result from the shearing of the brick top from the concrete base before full resistance of the monolith was developed. This allowed the specimens to develop at most only the sum of the resistances of the two parts.

With possibly one exception (slab 106) the grouted-brick tops with sand-cement cushions on concrete bases showed less resistance than the monolithic sections.

Grout-filled brick tops with sand and screening cushions on concrete bases showed slightly greater resistances than would be expected from the bases alone.

Grouted-brick surfaces compared favorably with 1:1½:3 slabs of equal thickness.

With few exceptions other than the monolithic slabs, the indications were that failure occurred because of in-

crease of the force of impact rather than by reputation of impacts of the same magnitude.

It was generally indicated that the resistance of the specimens increased with an increase in the bearing power of the subgrade as shown by the subgrade determinator.

There seemed to be no direct relation between the moisture content and the supporting value of the subgrade.

Practical Application of Results

In all the impact experiments which have been conducted by the Bureau of Public Roads the end which has been constantly kept in view is the development of a rational method for the design of roads to withstand this destructive force.

The manner in which the test results can be utilized is illustrated by the following example in which the conditions assumed correspond to the conditions of the tests:

Let us suppose a concrete pavement is to be designed to sustain safely the impact of a 5-ton truck loaded to capacity. It will be assumed that the character of the road surface and the condition of the tires of the vehicles which will use the road are such that the impact of the vehicles will be equivalent to that which would result by dropping the rear wheels from a height of ¼ in. Let it be assumed also that the pavement is to be designed to span small areas in which it will receive very little subgrade support, a condition similar to that which existed in the tests.

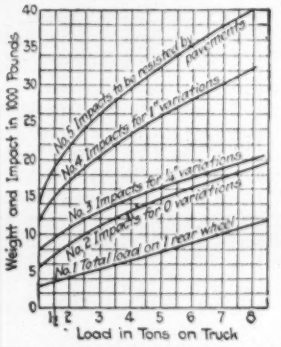
TABLE V. IMPACT CAUSED BY DIFFERENT MOTOR TRUCKS

Rated Cap. of Truck, Tons	Load, Tons	Load on One Rear Wheel, Lb. Total	Sprung	Unsprung	Equivalent Static Load for Different Heights of Fall, Lb. 0	¼ Inch	1 Inch
1½	1½	3,475	2,410	1,065	5,500	7,800	10,200
1½	1½	3,475	2,410	1,065	4,500	6,300	11,500
1½	2½	4,240	3,175	1,065	4,700	10,000	16,000
1½	2½	4,240	3,175	1,065	4,900	5,900	9,200
2	2	4,300	3,300	1,000	6,800	7,800	11,500
2	2	4,300	3,300	1,000	6,800	8,500	13,400
2	2	4,300	3,300	1,000	6,800	7,900	11,000
2	2	4,300	3,300	1,000	6,800	7,500	11,000
2	3	4,900	3,900	1,000	7,200	8,500	14,000
2	3	4,900	3,900	1,000	7,300	8,600	13,700
2	3	4,900	3,900	1,000	6,800	8,000	11,000
3–3½	2½	5,150	3,450	1,700	8,400	9,200	15,700
3–3½	2½	5,150	3,450	1,700	8,200	8,700	11,800
3–3½	2½	5,150	3,450	1,700	8,200	9,300	14,100
3–3½	2½	5,150	3,450	1,700	6,900	9,200	21,500
3–3½	2½	5,150	3,450	1,700	8,000	8,200	12,200
3–3½	2½	5,150	3,450	1,700	8,700	8,200	13,000
3–3½	4½	7,000	5,300	1,700	.....	10,000	19,000
3–3½	4½	7,000	5,300	1,700	9,700	9,700	19,000
3–3½	4½	7,000	5,300	1,700	9,300	9,800	17,700
3–3½	4½	7,000	5,300	1,700	9,200	11,000	17,200
3–3½	4½	7,000	5,300	1,700	10,000	10,000	18,000
3–3½	4½	7,000	5,300	1,700	10,000	11,000	15,800
5	5	7,900	5,950	1,950	11,000	12,800	18,000
5	5	7,900	5,950	1,950	11,000	12,500	19,000
5	5	7,900	5,950	1,950	9,000	10,000	16,000
5	5	7,900	5,950	1,950	9,200	10,700	15,500
5	5	7,900	5,950	1,950	9,200	9,700	13,000
5	5	7,900	5,950	1,950	9,500	.....	15,000
5	7½	10,600	8,650	1,950	12,200	15,300	26,000
5	7½	10,600	8,650	1,950	12,000	13,700	21,000
5	7½	10,600	8,650	1,950	11,500	12,500	18,500
5	7½	10,600	8,650	1,950	11,500	12,600	17,200
5	7½	10,600	8,650	1,950	11,000	11,200	16,800
5	7½	10,600	8,650	1,950	11,200	12,100	15,800

To meet these conditions the designer would refer first to the results of the measurement of motor truck impact. (See *Engineering News-Record*, March 31, 1921, p. 553.) A brief summary of these results is given in Table 5. The table shows the impacts delivered by the rear wheels of trucks of various sizes variously loaded and dropped upon the road surface from three different heights. The average impact resulting from a ¼-in. drop of the rear wheels of a 5-ton truck loaded with 5 tons, as shown, is equivalent to a static load of about 11,000 lb.

Several corrections must be applied to this value before it can be used. In the first place the tabular values represent the impacts delivered by trucks equipped with new solid tires. The tests showed that the use of worn tires might increase the impact by from 15 to 60 per cent. Assuming that the use of badly worn tires will be prohibited by law, let us apply a correction of 30 per cent which will increase the tabular average to 14,300 lb. equivalent static load.

Also, since the tabular values were obtained by the use of ½ x ½-in. copper cylinders, they are less than the true impacts, and it will therefore be necessary to apply a correction. Finally, as insurance against overloaded trucks, and other conditions such as the use of nonskid chains, which would increase the impact, let us double the estimated impact. The tabular values of impact increased by 30 per cent for tire condition and corrected to eliminate the effect of the copper cushion are shown in curves 2, 3 and 4 of Fig. 1. Curve 1 shows the total static load on one rear wheel and curve 5 shows double the value of the corrected impacts for the ¼-in. drop. In each case the impacts or loads are shown in relation to the load carried


Weight and Impact in 1000 Pounds
No. 5 Impacts to be resisted by pavements
No. 4 Impacts for ¼" variations
No. 3 Impacts for ½" variations
No. 2 Impacts for 0 variations
No. 1 Total load on 1 rear wheel
Load in Tons on Truck

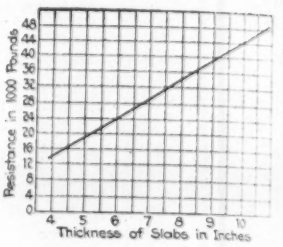


FIG. 1. TOTAL WHEEL LOADS AND IMPACTS FOR TOTAL LOAD CARRIED ON TRUCK (LEFT)

FIG. 2. RESISTANCE OF DIFFERENT THICKNESSES OF 1:1½:3 CONCRETE SLABS (RIGHT)

by the truck. Referring then to curve 5, we find that in designing a pavement for a 5-ton truck loaded to capacity, provision must be made for an equivalent static load of 32,500 lb., which is slightly more than four times as great as the total load on one rear wheel of the truck as shown by curve 1.

Having thus determined the impact for which the surface is to be designed, the thickness required is indicated by the results of the slab tests reported in this article. For 1:1½:3 concrete slabs the average results of these tests are shown in Fig. 2, which gives the resistance of slabs of various thicknesses. Referring to this figure it is found that a 1:1½:3 concrete pavement to withstand the impact of 5-ton trucks loaded to capacity and operated under the assumed conditions must have a thickness of between 7½ and 8 in.

Proceeding in a similar manner from other assumptions it can be shown that the thicknesses of 1:1½:3 concrete required for various sizes of trucks are as follows. For a 1½-ton load, 5 in.; for a 2-ton load, 5.5 in.; for a 3-ton load, 6.4 in.; for 4 tons, 7.1 in.; for 5 tons, 7.7 in. and for a 7½-ton load, 8.9 in.

These thicknesses are given merely as the results of an example which is cited to illustrate a method of design. They are not to be considered as the proper thicknesses of actual pavements to accommodate vehicles of the several capacities; nor is the curve in Fig. 2 to be understood to represent anything other than the average relation of resistance to thickness in the particular tests which have been described.

One of the reasons why the results can not be generally applied is that they relate only to the special subgrade conditions which existed at the Arlington experimental farm.

Another obvious reason is that the slab resistances used were derived from tests in which the impact was delivered only to the centers of the 7-ft. slabs, and it is known that this is the most favorable condition. Less resistance would have been offered to impact applied at their edges, and still less to blows delivered at their corners.

These reasons indicate the need for further research. In respect to the subgrade the first need is to devise a

method by which the supporting value may be measured, the next is to find out how and to what extent it is affected by moisture and other natural conditions. These problems solved, it will still be necessary to study the changes which affect the shape of the subgrade, such changes, for example, as are caused by frost and the pounding of traffic, for with rigid surfaces the support offered by the subgrade depends not only on its supporting value but also upon the nature of its contact with the surface. And this study will necessarily include the behavior of the surface as well as the subgrade, for the desired contact may be lost by the movement of the road slab itself. The bureau's tests have shown already that such movement occurs daily as a result of temperature changes.

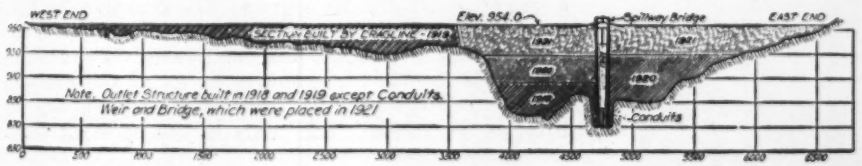
The determination of the edge and corner resistance of the slab presents no great difficulty. It is confidently expected that reliable data on this subject will be developed by tests now under way; and with the knowledge gained it should not be a difficult matter to design all parts of the slab to have equal strength.

What doubt remains as to the intensity of the impact which may be delivered by vehicles operating on actual roads should be cleared up by means of the impact recorder designed by the bureau and awaiting only minor adjustments preparatory to experimental use. This apparatus, attached to a motor truck, will give autographic space-time curves similar to those drawn by the instrument attached to the stationary impact machine, and thereby permit the measurement of impact on actual highway surfaces.

Other tests which are already in progress will yield further data on the resistance offered by bituminous-topped and reinforced-concrete pavements. If the subgrade problem can be solved satisfactorily the information which will ultimately become available should give a very clear conception of the type and thickness of pavement necessary for any given kind of traffic.

Lockington Dam Completed

LOCKINGTON DAM, the second of the finished hydraulicking operations of the Miami Conservancy District, was completed in October. The structure contains about 1,000,000 cu.yd., is 6,000 ft. long, 25 ft. wide on top, 460 ft. thick (maximum) at the base, and 78 ft. high above the outlet conduit floor. Construction was begun, on hydraulic fill, June 12, 1919, and the progress is shown by the accompanying progress profile.


WEST END
Elev. 954.0
Spillway Bridge
EAST END
Note. Outlet Structure built in 1918 and 1919 except Conduits, Weir and Bridge, which were placed in 1921
Conduits

PROFILE OF LOCKINGTON DAM SHOWING PROGRESS BY YEARS

The dam cost $1,280,000 complete, including engineering, superintendence, depreciation, clerical labor, materials, supplies, and everything expended on construction. The hydraulic fill cost 75c. per cubic yard; the dragline fill at the west end of the dam 23c. per cubic yard; the excavation (rock) for the outlet works and channel 69c. per cubic yard, and the concrete work an average of $9.84 per cubic yard.

Wages during the period of construction varied considerably, rising during the war and falling sharply during 1921. During the period in which the most of the work was done, common labor received from 38c. to 46c. per hour, and good carpenters, 65c. to 80c. per hour.

The price of materials varied widely. The major part of the cement was purchased f.o.b. Lockington for $3.06 per bbl., with 25c. sacks; $2.92, with 15c. sacks, and recently $2.91, with 10c. sacks. Coal was purchased for $4.19 to $4.65 per ton, run of mine, f.o.b., Lockington. Much of the material used was special, and the prices paid are not comparable with prices paid on other work. Barton M. Jones was division engineer in charge of construction.

Sludge Dewatering With Hot Sulphur Dioxide Gas and Live Steam

EXPERIMENTS with the dewatering of sewage sludge with a mixture of hot sulphur dioxide gas and live steam are being made on activated-sludge at Texas, and on various types of sewage sludge and garbage tankage at Indianapolis by the Maclachlan Reduction Process Co., New York City. A full size installation is under construction at the activated-sludge plant now being built at Gastonia, N. C., after plans by William M. Piatt, consulting engineer, Durham, N. C.

In this process, the hot sulphur dioxide gas is produced by burning crude sulphur in a special type of burner, the resulting fumes being mixed with live steam and blown into the sludge as it flows through a treating tank. The mixture of gas and steam, according to the company named, "has an instantaneous electrolytic effect upon the sludge which destroys its flocculent nature. In the case of sludge having a 98 per cent water content, the sludge after treatment quickly settles to 95 per cent water, which means a reduction of 60 per cent in volume. At the same time the solid particles of the sludge are converted to a granular condition which renders them more easily and quickly pressed." At the Houston plant, the company states, "the gas is applied to the sludge for 2½ min., raising its temperature from 80 deg. F. to 135 deg. F. The sludge is then pressed hot in the filter press already installed in connection with the large dehydrating plant, the cycle being 3 hr. 20 min. This yields a cake containing as low as 74 per cent water, which is then dried in the indirect dryer forming a part of the large dehydrating plant already mentioned."

Continuing the company states: "Experiments with dewatering the Houston gas-treated sludge on sand beds show great promise. Dosing at the rate of 1.3 lb. of dry solids per square foot of sand bed yields a ⅜-in. cake of 64.5 per cent water content in 24 hr. At double this rate a 1½-in. cake with 77.5 per cent water is obtained. Untreated sludge would not drain appreciably in 96 hr., the moisture being reduced only to 96 per cent." The company estimates that its dehydration process would cost from $0.75 to $3.00 per ton of dry solids, depending upon local conditions.

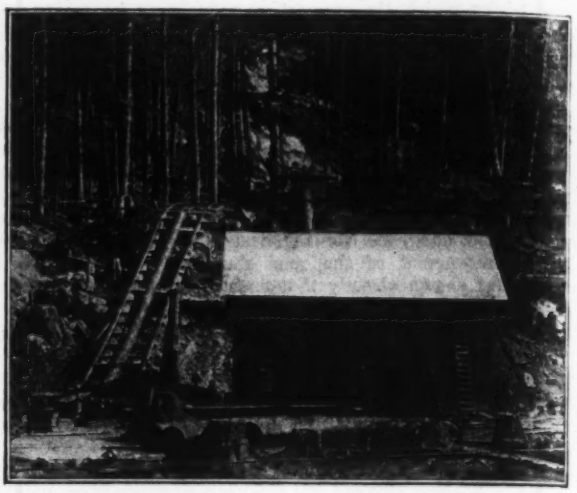
Waterfront Bulkheads: (Correction)

Titles to illustrations were misplaced in the article on "Waterfront Bulkhead Construction," in *Engineering News-Record* of Oct. 13, p. 614. The larger drawing on p. 614 shows the Chicago work and the smaller drawing on p. 615 shows the Milwaukee work.

Progress on the Skagit River Power Project

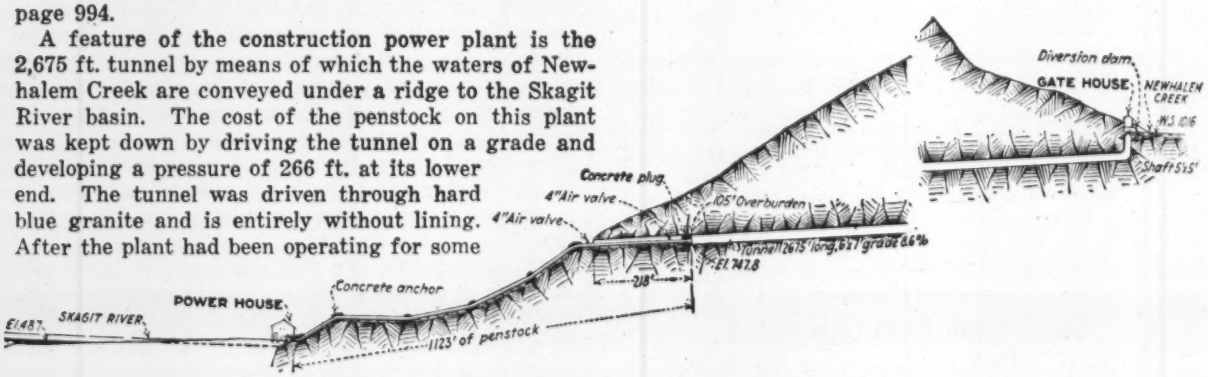
Seattle Has Completed 23-Mile Railroad and Construction Power Plant—Work on 2-Mile Main Tunnel Is Under Way

WORK is now well under way on the Skagit hydroelectric development which is being carried out as a municipal venture by the City of Seattle. The Gorge Creek plant, the first main unit, is expected to be ready for service in the latter part of 1923. A construction railroad, 23 miles long from Rockport, Wash., the nearest point on existing rail line, was finished early this year; the 3,000 hp. Newhalem plant built to supply power for construction purposes was completed in the late summer and work has just been started on the 10,978-ft. tunnel which is to serve the Gorge Creek Plant. Contract for this tunnel was awarded to the R. C. Storrie Co., San Francisco, for $2,203,865. The general features of the project were described in *Engineering News-Record*, No. 18, 1920, page 994.



TEMPORARY POWER PLANT ON THE SKAGIT PROJECT

A feature of the construction power plant is the 2,675 ft. tunnel by means of which the waters of Newhalem Creek are conveyed under a ridge to the Skagit River basin. The cost of the penstock on this plant was kept down by driving the tunnel on a grade and developing a pressure of 266 ft. at its lower end. The tunnel was driven through hard blue granite and is entirely without lining. After the plant had been operating for some weeks the tunnel was unwatered and examined thoroughly without finding any change in cross-section from the original finished excavation. A precautionary measure to prevent leakage was the continuation of the penstock for 218 ft. into the lower end of the tunnel, thus making it possible to plug the tunnel with concrete at this point and remove the pressure from all the lower end on which the overburden is less than 105 ft. No seepage has appeared on the slope of the mountain which the tunnel transverses. The penstock is 1,122 ft, long, and varies in diameter from 33 in. at the upper end to 30 in. at the bottom, with a thickness ranging from ⅜ in. at the top to ½ in. at the bottom. All joints in the penstock were electrically welded.



CROSS-SECTION THROUGH NEWHALEM POWER DEVELOPMENT

CONSTRUCTION CAMP FOR SKAGIT POWER JOB

In the plant a double overhung impulse wheel operating under a head of 510 ft. is direct connected to a 2,200 kw. generator. In testing out this unit a 2,100 kw. load was tripped instantaneously to see what the control apparatus would do. Under these conditions, approximately the most severe test that could be imposed, the water-wheel governors allowed an increase of speed of less than 30 per cent, which was considered very satisfactory regulation. At least in part, this close control is ascribed to the fact that each runner on the double overhung unit is controlled by an independent governor. A motor generator set is being installed in the plant to provide D. C. current for the three-mile railroad extending from the saw-mill to the dam site and which it is planned to electrify.

The main construction camp is located on a bend

of the Skagit River, 23 miles by the construction railway from Rockport and about 2¾ miles from the Gorge Creek dam site with which it is connected by a railroad. The camp consists of 14 bunk houses with sleeping quarters for 24 men each, fifty 3-room cottages for the married men, mess house, warehouses, office buildings, etc. With the exception of the married quarters the entire camp is heated from a central heating plant.

The foregoing has been prepared from information supplied by C. F. Uhden, chief engineer, Skagit River Power Project.

Later Work, Not Education, Raises Professional Status

BY CHARLES A. HOLDEN
Director Professor of Civil Engineering, Thayer School of Civil Engineering

THE EFFECTIVENESS of a pre-college course in engineering education has been demonstrated by those institutions which have required such preliminary training. One advantage of such a course which is generally unrealized is the opportunity offered the student to continue his general college course and then to enter a vocation for which he is better suited if he does not show aptitude in subjects required for an engineering training.

However, the deduction that the status of the medical profession is due to the requirement of an academic training before the professional work is perhaps not warranted, since the standing of the profession was established long before the present educational requirements were formulated.

Factors entirely outside of the educational program as usually interpreted exert a very vital function in the relative positions occupied by the lawyer, doctor, and engineer, and it is largely to the period after graduation that the engineer must look for improvement in his status. By the nature of their professions the lawyer and doctor are brought in intimate association with the members of their community and there develops from this association an interest in community affairs so that they are held in esteem not only for their professional attainments but as vital forces to be consulted in matters affecting the public weal.

The engineer is inclined to berate politics, to consider that his activities are not concerned therewith and to isolate himself from community interests with the inevitable result that he is not a vital force in public matters. His attitude should be exactly the reverse. He should realize that no class of men is better trained for civic responsibility. Community problems are concerned largely with highways, water supply, sewage disposal, bridges, buildings, lighting and similar subjects for which the engineer has a special training. If he has been educated under the definition "engineering, the art of organizing and directing men, and controlling forces and materials of nature for the benefit of the human race," he recognizes that the engineer has relationships with "mind and human action" as well as with "matter and energy."

For other problems which arise he is better prepared than many who are concerned with community affairs for he has been taught first to state the problem, next to indicate the principles which underlie the solution, then to formulate the general statement of the solution and finally to solve it. The first three parts are of fundamental importance and lead to results greatly superior to those where they are omitted, as is too often the case. There are many conspicuous examples of engineers who have appreciated their opportunities and responsibilities and have rendered valuable services to country, state and town When engineers in general reach a like appreciation, each community may support its engineer as well as its lawyer and doctor.

Then also as to the professions of law and medicine, there is in the public mind much of mystery. It is realized that powers of analysis and a knowledge of previously determined procedure, principles and facts are required to solve the problems involved. Troubles from law suits, sickness and death are ever-present forces, thrusting home the importance of these professions and demonstrating the inevitable penalty experienced through the neglect of their aid.

But a farmer may become a contractor and lay concrete floors and side walks. The previous conditions are greatly improved and the public is not cognizant of the less cost possible to secure as good results by different mixtures of cement, sand and stone, or a different selection of the latter two, nor of the better product which could be obtained at the same cost by the engineer trained in the making of concrete.

The improvement of the status of the engineer must be obtained largely through individual and collective effort after graduation. The educational program should be formulated to prepare for the broad definition of engineering given above. It will realize that the ultimate aim of all education is to assist in improving civilization and that since the engineer is to do this through engineering, the program must include a sound training in the science underlying engineering.

An Unusual Sewage-Works Combination

AN UNUSUAL combination of sewage treatment elements is found in a plant with a nominal capacity of 1,200 U. S. gal. capacity for a mansion named Olantigh Towers at Wye, Kent, England. This plant, to which nearly two pages of the London *Engineer* of Nov. 4, 1920, are devoted, was designed by Major Hilder Daw, late lecturer on sewage disposal at the South-Eastern Agricultural College at Wye. Aside from the utilization of an existing grit chamber and sewage receiving reservoir, the new plant consists of activation by repumping the sewage some thirty times and discharging it in the face of a horizontal air blast that drives the sewage against "eddy plate" where it is broken up for aëration purposes; sedimentation and sludge digestion, by means of a two-story settling tank, which in section is something life a half of an Imhoff tank; and (3) final treatment by sprinkling or percolating filters with an alternating-tip dosing device.

The sewage is pumped from the receiving tank vertically upward to a point where a thirtieth of it passes on to the sedimentation tank and the remainder drops back into the receiving tank, passing as it falls between the air nozzle and the eddy plate already mentioned. Nearly 300 cu.ft. of air per U. S. gal. of sewage is supplied. Water power drives both pump and air blower.

ANALYSES OF SAMPLES TAKEN AT VARIOUS POINTS IN THE SEWAGE-WORKS AT OLANTIGH TOWERS

	Parts per 100,000				Percentage Purification
	Raw Sewage	Storage Tank	Sedimentation Tank	Effluent	
Ammonia, saline	9.87	2.400	2.500	0.065	99.34
Ammonia, "albuminoid"	1.400	0.500	0.200	0.70	95
Oxygen absorbed at 27 deg. C. in 4 hr.	2.79	0.710	0.413	0.272	90.2
Nitrates	Absent	Absent	Absent	1.25	....
Nitrites	Absent	Absemt	trace	trace	....
Suspended matter*	absent	absent	trace	trace	....
Suspended matter*	744.0	68.0	22.0	1.30	99.9
Do. do., coarse	913.4				
Total	1,657.4				

* The proportion of suspended matter recorded as "coarse" was obtained by straining the sample through a sieve of about thirty meshes to the inch.

Working at only about one-fourth capacity after apparently some three months of use the treatment at various stages is reported in *The Engineer* to have given the analyses shown by the accompanying table.

The journal quoted also states that "the system of sewage disposal described above is being exploited by the Aer-sed-con Sewage Purification Plant Co., 9-10 Southampton St., Holborn, London, W. C. 1."

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

More Defense for Engineer as Manager

Sir—Mr. Cabot in *Engineering News-Record*, Oct. 27, p. 692, indicts the engineering profession as failing to develop managers of large enterprises. His views are interesting as coming from a firm of well-known bankers, and his sincerity cannot be questioned. However, I take issue with his statements because (1) the supporting evidence is insufficient to justify his conclusion; (2) no indictment of a part of a group is likely to be true of the whole group; (3) as a contrary statement to the views of Mr. Cabot, engineers have cleaned up some infernal messes which have been made by promoters he applauds so highly, and (4) because an engineering training when supplemented by experience in handling men and dealing with business affairs is a most excellent foundation for the management of a very large percentage of the industrial problems and industrial plants of today.

Mr. Cabot has visualized the engineer as a man cold and austere in his beliefs and formulas; a man untouched by the human feelings and passions of the ordinary man. He has sought to interpret him as a sort of business surgeon, a man whose passionate love of detail makes it impossible for him to see the human elements in any business plan. There are many engineers of this type, but to generalize on this basis leads to a fallacious conclusion. I grant that the average engineer is trained in a hard school of exactness, but does exactness make a poor manager? He is a great student of detail, but does a knowledge of detail make a poor manager? He is analytical and perhaps austere in his viewpoint, but does cool judgment make a poor manager? He lacks in the quality of salesmanship; this may make a humble manager but it makes a safe one as he says. Is safety a quality to be laughed to scorn?

Qualities of leadership are improved by training, but they are born in a man regardless of what his training may be and they develop through opportunity. Engineering is a severe task master and an engineer must often maintain a critical attitude. The examples that Mr. Cabot has taken do not include those engineers who have made a success as manager. I venture to say that of late years more men with engineering training have succeeded as managers of large enterprises than men without such training. The names of these men could not be printed on this page—it would be too small. He has forgotten Goethals, Newell, Hoover, Atcheson, Finley, Mulholland, Hammond, Cassatt, Epes Randolph and a host of others. The list is a long one and growing longer every day.

Prior to 1900 very few industrial executives received engineering training. Since 1900 a much larger proportion has received such training and these men are now coming into their own as managers of large enterprises.

Mr. Cabot's example of the management of the railroads is an unfortunate one. During the period in which, as he says, they made money in the hands of promoters, money was made at the expense of the railroads, and when they got in such a terrible mess that no one else could handle the job of straightening them out, they were turned over to engineers and bankers. If bankers and engineers cannot work out the problems of the railroads who else can?

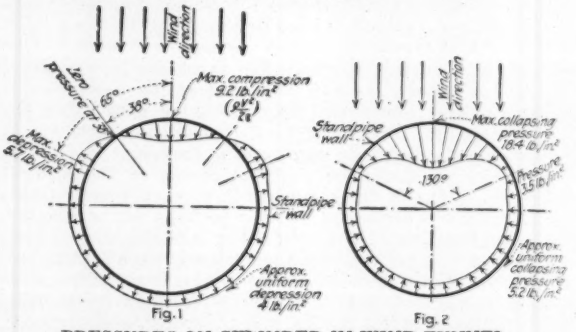
It is amusing to think of engineers as lacking in vision and imagination. The trouble is that real engineers have been so busy thinking and planning in big terms that they have forgotten to convince other people that they are doing this sort of thing. The new era in the profession finds it attentive to public relations and public service. In but a few years the new concept will produce a rich fruition.

Chicago, Nov. 23. C. E. DRAYER,
Secretary, American Association of Engineers.

Wind Forces on Standpipe Deduced from Pressure-Tunnel Results

Sir—In your issue of Oct. 13, p. 601, appears an article "Repairs to a Wind-Indented Standpipe at Bath, Maine," by C. E. Carter. The photograph of this article illustrates in an interesting way the pressure distribution which we know, by aerodynamical analysis, to exist on the walls of a cylinder when subjected to air flow. In the two diagrams herewith, from tests made in a wind tunnel, there is a good analogy to the wind pressure which caused the collapse of the standpipe mentioned; and from the wind-tunnel test we can deduce the actual pressures, both qualitatively and quantitatively.

The test cylinder is subjected to artificial air flow in the wind tunnel; the pressures produced at various points on the surface are led off through minute holes communicating with tubes on the interior, and they are recorded on suitable manometers. Neglecting small-scale effects and other corrections familiar to the aeronautical engineer, these diagrams apply to the standpipe.



PRESSURES ON CYLINDER IN WIND TUNNEL

Fig. 1 shows the pressure distribution on the outside of the standpipe. In the diagram a vector is drawn at every ten degrees of the circumference, giving by its direction and length the intensity of the force acting. Arrows pointing toward the center are for positive pressures, tending to collapse the standpipe; those pointing away from the center are for negative pressures, tending to stretch the plate. The ends of the vectors are connected by a smooth curve. There is positive pressure over the front 76°, which reaches the theoretical value $\rho V^2/2g$ at the extreme front. At all other points than the extreme front the pressures can be determined only empirically. To the rear of the 38° point they become negative, reaching a maximum 65° off the wind direction, where the intensity is $0.6\rho V^2/2g$ of sign opposite to the front portion. The rear 180° is subjected to "suction" which is substantially uniform and equal to $-0.44\rho V^2/2g$.

Note the buckling moments at the 38° point of the diagram, where the maximum positive pressure moment is added to the maximum negative pressure moment. In the photograph, the point of buckling is in this neighborhood. An interesting feature appearing in the diagram is that portion between 38 and 90°; the suction here tends to draw the surface against the wind.

In order to determine the true pressure which operated in the collapse of the standpipe (assuming the latter empty of water), we have to take account of the chimney effect, i.e. the depression due to flow of wind across the open standpipe mouth. This has been done in Fig. 2, which therefore gives the net forces acting both inside and outside the walls. From the pressures of Fig. 1 a uniform amount is subtracted numerically exceeding $\rho V^2/2g$ by an amount determined in the wind tunnel, and of opposite sign. The net wind effect, as shown by Fig. 2, is that every portion of the empty standpipe is under a stress tending to compress the plate.

E. N. FALES,
Aeronautical Engineer, U. S. Air Service.

Dayton, O.
Oct. 24.

One Way of Specifying

Sir—Here is an architect's specification for the drains in connection with the foundation work for a church.

> *Drain*—Properly prepared to meet any conditions that might arise so that we may prevent an absolute condition to positively avoid any possibility of water at any time, under any condition, entering the cellar."

Evidently he wants a dry cellar!

Hackensack, N. J. CONTRACTOR.

Analytical Data Essential To Run Mechanical Filters

Sir—Referring to the article on "Analytical Data Essential to Run Mechanical Filters," on p. 353 of your issue of Sept. 1, I venture to predict that the practical laboratory control of water purification will increase rather than decrease during the next 25 years. I agree fully with Mr. Brown that a careful selection of the laboratory tests should be made and in one-man purification plants that the number and frequency of such tests should be reduced to a minimum, but the selection will vary with different classes of water and the plants required for their purification. Moreover, the selection of tests should be made by open-minded men who from experience are capable of deciding upon useful tests which will show the operators what they are doing; will serve as a record of the operation of the plants; will be of value in answering complaints concerning the quality of the water and will be of assistance to the state department of health.

However, I believe that the views of Mr. Brown will make a wrong impression on a considerable number of those who read the article and also on some of the water-works men for whose benefit it was probably written. To a layman interested in one or more water-works from a purely business standpoint, or to those "who cannot qualify even as amateurs" but "pass upon highly technical questions with more of assurance than is assumed by the expert"—as aptly expressed by Edward E. Wall, water commissioner of St. Louis—and especially so when possessed of a little brief authority, great presumption, and a narrow mind, Mr. Brown's paper will come as a welcome reinforcement to bolster up their ideas of the false economy and of the unnecessary refinements of laboratory control of purification plants.

Mr. Brown assures us that "the hardness cannot be reduced by merely reporting it and unless softening is carried on, it has no place in a report." Carrying out his analogy I might say with equal assurance that the mere determination of bacteria in filtered water will make the filters neither more nor less effective; that the making of presumptive or partially confirmed tests for B. Coli will not prevent those in the water from passing on into the distribution system; that the determination of chlorides will not prevent a water supply from becoming salty to the taste; that the determination of iron will not prevent the staining of porcelain fixtures when an excess is present in a water supply; and so on, yet these are not valid reasons for a wholesale omission of such tests.

Mr. Brown apparently has it in for the "37½-deg. C. count" and wishes to make it unquestionably clear that this test stands out as the most worthless member of the "black sheep" of the family of "more or less valuable tests." I will admit that considerable time is consumed in preparing for and in making this test but practically the same amount of time is required for the "20-deg. C. count," which is obtained 24 hours later than the 37-deg. count. Furthermore a 20-deg. incubator is harder to maintain at constant temperature in the laboratory of a small water-works than is a 37-deg. incubator. However, this is not a suitable place for a detailed comparison of the advantages and disadvantages of these two classes of counts and much has been written on the subject. I am of the opinion that the majority of purification and chlorination plants may be operated by the aid of 37½-deg. C. counts so that the effluents will meet the requirements of the Treasury Department, if those in authority wish to meet these requirements.

As a matter of fact, the "Bacteriological Standard for Drinking Water" adopted by the Treasury Department (U. S. Public Health Service) for drinking water supplied to the public by common carriers is more widely used as a standard than any other and includes the following ruling: "The total number of bacteria developing on standard agar plates, incubated 24 hours at 37 deg. C., shall not exceed 100 per c.c." As long as this standard is in use a considerable number of purification plants will have to make 37½-deg. C. counts in order to show that their effluents meet this standard and will have to be guided in their operation by such counts. By making such counts and operating purification or disinfection plants by their aid in order to keep the bacteria below 100 per c.c. how are the operators going to run into the "great and varied difficulties" which Mr. Brown holds up like a red flag? It is more probable that "great and varied difficulties" will result if operators furnish waters to common carriers which do not meet the "Bacteriological Standard for Drinking Water" on account of not carrying on a sufficient amount of laboratory supervision.

In the majority of purification plants I believe that the operator should take the color of the filtered water at least once a day on a catch sample and preferably on a representative composite sample collected during each 24 hours. Why is it a waste of time to check roughly the dosage of alum to the raw water by the determination of the color of the filtered water? Why is it a waste of time to make a permanent daily record of a test which takes such little time in its making and sooner or later will be required as evidence to show that the plant has been operated so as to deliver an effluent of pleasing appearances. In some cities the broad-minded men in charge of the water-works prefer to deliver a water of zero color to the consumers rather than one with a color of 10 p.p.m. From a material standpoint there may be little difference between the two waters but from an esthetic standpoint there is considerable difference and the average consumer will point with natural pride to a clear, sparkling and colorless water. How can such a water be obtained unless the operator determines the color and turbidity? If operators of purification plants, both large and small, would spend more time looking at their filtered water with a critical eye, even if contained only in a 2-qt. bottle of clear flint glass, they would find oftentimes that they are not such wonderful operators as they think they are.

Take the test for residual chlorine which appears to have escaped Mr. Brown's steam roller. This test should be made at every waterworks, both large and small, in connection with the application of liquid chlorine or hypochlorite to a water supply, not only on samples collected near the point of application of the disinfectant, but also on samples collected at one or more points on the distribution system. This test intelligently applied by a man with common sense will be of great assistance to him in regulating the dosage of the disinfectant so as to prevent the addition of a needless excess with the resulting production of tastes. It will also enable him to detect changes in the power of the water to absorb greater or smaller quantities of chlorine so that the dosage may be increased or decreased to obtain the proper disinfection of the water.

In view of the recent developments on the reaction of aluminum sulphate with the alkalinity of a water, it appears to be reasonable to expect that some sort of a practical determination relating to the detection of aluminum compounds will come into use. Even the determination of the hydrogen-ion concentration of a water in the near future by a man in overalls may not be such a wild vision in spite of "great and varied difficulties."

GEORGE C. BUNKER,
Balboa Heights, C. Z., Sept. 24. Sanitary Engineer.

Sir—Mr. Bunker seems to have missed the whole intent of my paper. My purpose was to call attention to the requirements and uses of data by two classes of workers: (1) filter operators; (2) sanitary authorities using the data to judge of the quality of the produced water. My paper stated that the requirements of the two must differ, and the needs of the men producing the results should come

first, while those judging the results without coming in contact with the work should come second. This, I contend, is a plain common sense view of the matter.

It is also stated that the man producing the results should not be overburdened with the necessity of producing a lot of data which, however valuable to the man attempting to judge the quality of the water, is of little or no value to the man producing the results. It contended that the men in actual charge of the plants should have more voice in formulating the methods and standards of analytical data to be used in the work than the men who do none of the actual work of production.

It went further and stated that when the operators decided what data were essential to their needs and requirements, any additional data required by the sanitary authorities should be provided by these sanitary authorities and paid for by them. The best results were deemed the most important matter, the necessary data to enable the operators to produce these results being the first desideratum; the data to enable some one else to judge the results being of secondary importance.

For more than twenty years, the writer has urged the necessity of a better class of operators in mechanical filter plants. There are more than enough sanitary authorities to inspect results but there are entirely too few men to go out and produce them. This is the greatest need of the day and expert operators or men able to develop into expert operators should have every encouragement given them. To load them up with a lot of unnecessary and useless work, as far as they are concerned, is not a policy to encourage them. Where such operators are available, they are fully competent to pass on the needs of their plants and decide on what tests shall or shall not be made to guide them in operation and they should be permitted to follow their judgment. Not even the officials of the U. S. Treasury Department should be permitted to dictate to these men as to how they shall handle their work. In my humble opinion, our state boards of health go entirely too far in attempting to control methods in some states. They may be entitled to demand certain results but it is a serious question if they should be permitted to attempt to control the methods by which these results are to be produced.

Mr. Bunker appears to be ignorant of the fact that the U. S. Treasury Department standard for drinking water supplied by common carriers was not intended to and does not apply to a filtered water supply. It has been stated that this standard, which has not proved satisfactory, is now undergoing study and will probably be changed somewhat in the near future.

As regards the 37½-deg. count, Mr. Bunker is also at sea because of his failure to understand other matters leading up to it. I have no quarrel with this count if properly used nor would I attempt to run a plant without using it to some extent. It is really as essential to good operation as it is to judge of the quality of a water of unknown origin. From the expert operators standpoint, however, its use, as generally employed, is indefensible, Mr. Bunker to the contrary notwithstanding. To state that any plant can be operated to the best advantage by using only the 37½-deg. count is to argue without adequate operating knowledge and experience. To state that it is more valuable as a guide to good operating than the 20-deg. count is to argue from the same viewpoint. Of the two, as far as operating is concerned, the 20-deg. count is an infinitely better guide and will point out danger and difficulty that the other may never even indicate.

The saprophytic far outnumber the pathogenic organisms in most water supplies. Many of these saprophytic organisms will grow on gelatine or agar at 20 deg. C but will not grow on agar at 37½ deg. C. Even though it takes 24 hours longer to get a count on gelatine or agar at 20 deg. than on agar at 37½ deg., the 20-deg. count gives information of vital importance to the operator days or even weeks before the 37½-deg. count can be expected to, even if the latter count ever gives such information. The information thus given by the 20-deg. count is of great importance to the intelligent operation of any mechanical filter plant. In most instances the 37½-deg. count, if it ever gives a hint of such difficulties, does so only when it is too late for the operator to prevent the trouble.

The reasons for this are well known to operators of broad knowledge, experience and skill. With the 20-deg. count on gelatine or agar, and with the settling basins and filters functioning properly, the plates at counting are of the same general character. The proportional distribution of the types of colonies are characteristic and easily noted. There will be no greater preponderance of one type of colony on a raw water plate than on a plate from the settled water or the filtered water, because the action of sedimentation or filtration is non-selective. If, on the contrary, aftergrowths are occurring during sedimentation or in the settling basins, the plates of settled water will show this immediately by a preponderating number of one type of colony on the settled water plate as compared with the plate from the raw water. If the difficulty is occuring in the filters themselves, the filter plates will show the same thing. The 37½-deg. count absolutely fails to give any indication of such conditions.

With the 20-deg. count, the operator is enabled to figure the efficiencies in percentages of removal by settling and by filtration, while with the 37½-deg. count this is not feasible. With the 20-deg. count, the operator therefore has a percentage basis by which he can judge the efficiency of these two steps in the process of purification, of which he is deprived if he uses only the 37½-deg. count. The moment his percentages fall off, he is given a warning that something is wrong and he has a chance to locate and correct the difficulty long before the conditions grew serious enough to be indicated by the 37½-deg. count, even if it is ever indicated by that count. *Ordinarily the 20-deg. count will indicate approaching trouble from two to ten weeks earlier than the 37½-deg. count can be expected to do.*

While the 20-deg. count will do these things, the 37½-deg. count is not without merit and should be used frequently, as a check, this being particularly desirable if the presumptive B. coli tests begin to appear suspicious.

Regarding Mr. Bunker's statements of color and chemical dosage, I would like to inform him that up here, when the raw water carries a color of 10 p.p.m. or less, the ordinary practice is to deliver a filtered water of zero color all the time. In such cases color is not used to determine the chemical dosage and may be ignored with safety, being covered by a general statement that the color in the raw water seldon reaches ten parts per million.

If Mr. Bunker will read the paper in full as presented at the Oklahoma City convention, I am of the opinion he will find I did not neglect the subject of chlorine and he may find I said more about this than he may deem justifiable. As a tomb to bury the mistakes of design, as a covering up for lazy and incompetent operation and letting things go until they get so bad that heroic measures are required to straighten them out, I cheerfully concede chlorine to be the whited sepulcher par excellence.

Taking it by and large, Mr. Bunker admits a good many things in his first paragraph and then proceeds by an interpolation of incompetence in operators to set up a lot of conditions which requires the balance of his criticism to answer.

C. ARTHUR BROWN,
Engineering Bureau-Water Purification,
American Steel & Wire Co., Chicago-New York.
Lorain, Ohio, Oct. 30.

Engineer Registration at Illinois

Of the 9,084 bona fide resident students enrolled in the University of Illinois this term 1,892 undergraduates have registered in the college of engineering. The courses offered and the number of students in each, are as follows: Architecture, 112; architectural engineering, 129; ceramic engineering, 72; chemical engineering, 218; civil engineering, 336; electrical engineering, 415; general engineering, 43; general engineering physics, 2; mechanical engineering, 418; mining engineering, 86; municipal and sanitary engineering, 10; railway engineering, 51; total 1,892.

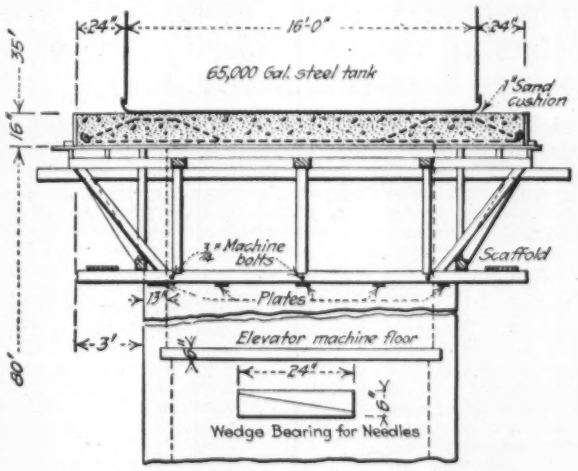
HINTS FOR THE CONTRACTOR

Simple Scaffold Carries Floor Center on High Tower

BY GEORGE A. DAVIS
Commissioner of Buildings, South Bend, Ind.

A SUCCESSFUL method of placing a concrete slab on a brick tower carrying a 65,000-gal. water tank, without using shores from the ground or exterior scaffolding, was devised by the writer, in 1920, for the O'Brien Varnish Co., South Bend, Ind. The tower was 14 ft. square and 80 ft. high and the operation was to place on top a reinforced-concrete floor 20 ft. square as indicated by the accompanying drawing.

In constructing the scaffolding the first step was to insert five ¼ x 4 x 4-in. plates in a mortar joint in each



SCAFFOLD BOLTED TO TOWER CARRIES FLOOR CENTERING

of the four walls about 6 ft. below the finished height of the wall. About 2 in. of each plate was inserted in the wall. The projecting parts took the shear of 4 x 6-in. timbers laid thereon and bolted through the walls with three ¾ x 18 in. machine bolts. The 4 x 6-in. timbers were used to scaffold and brace four. The ¾-in. bolts were wrapped with paper to prevent the cement mortar from adhering to them. The 4 x 6-in. timbers were placed and bolted as the walls were built up. Three needle holes were also left in each wall near the top, to take care of three 6 x 6-in. needles crossing each other at right angles. Each wall bearing of the needles was two wedges as indicated by the drawing. The needles were 12 ft. long and were butt-jointed at the center with a splice nailed over the joint. The interior centering was braced up from the last put-log brick scaffold, and the exterior was braced from the 4 x 6-in. timbers bolted to the walls. The joist and decking were laid on top of the 6 x 6-in. needles as shown.

Wrecking the forms was easily accomplished by first removing the 6 x 6-in. wedges, the shores and the braces. The wedges were removed uniformly all around, lowering the whole 6 in. The subsequent operations were: (1) Removing the joists and decking, (2) removing the needles from the inside, (3) filling the needle holes from the scaffold carried on the 4 x 6-in. timbers, (4) drifting out the ¾-in. bolts and lowering away the 4 x 6-in. timbers by two men with ropes from above, (5) rapping loose and knocking out the ¼-in. plates with a long-handled hammer from above and (6) filling the bolt holes and mortar joints displaced by the plates, with glaziers' putty.

Economy in the Use of Dynamite

THOSE having to do with blasting rock are liable, says a recent article in *Engineering and Mining Journal*, always to use a certain number of sticks of powder for a hole of a given depth, taking no consideration of the quality of material being blasted. If the hole breaks well the operator is satisfied, even though an excess of powder may have been used. The use of a certain number of sticks of "extra" dynamite where an equal number of sticks of a 35 per cent powder would suffice, is apparent waste.

The foreman may, therefore, effect a saving in the use of powder through counting the sticks and by loading with different grades. In a 50-lb. box of extra dynamite there are about 100 sticks, 1¼ in. x 8 in., and 135 cartridges of 35 per cent powder. The higher grade explosive is much more expensive and there are fewer sticks to the box, so the cost per stick is much greater.

Rusted Pipe Removed from Coupling

SOMETIMES an iron pipe, as in the case of a gasoline-engine exhaust pipe, becomes so rusted into the flange coupling that it cannot be removed. In order not to destroy the flange the pipe can be sawed off about halt an inch from the coupling, then a hack-saw cut made through the stub end, lengthwise. A cold chisel is then applied to the outside of the projecting end, at the cut, and by gradually working around the pipe it can be loosened from the threads in the flange, curled up and removed without injuring the coupling threads.—*Power.*

Rapid Earth Handling on Stanford Stadium

About 90 per cent of the earth work on the stadium at Leland Stanford Junior University in California has been placed and the structure is to be finished in time for the intercollegiate football game on Nov. 19. This job on which construction started June 5 involves the moving of 232,000 cu.yd. of earth and the placing of 800,000 ft. b.m. of lumber in the bleacher structure. Rush construction methods were a prime consideration as the work was undertaken this year only with the understanding that the stadium could be used for the championship game which brings in the biggest revenue of the season. The excavation is being made with elevator graders drawn by caterpillars and delivering to dump wagons hauled by mules. Within a week after the work was started earth was being moved at the rate of 1700 cu.yd. per 9-hour day and this rate was steadily increased to a maximum of 3686 cu.yd. per day using three graders and 200 mules. Earth has been excavated by the graders and loaded into dump wagons at rates as high as 81 wagons per hour, each carrying 2 cu.yd.

NEWS OF THE WEEK

New York, December 8, 1921

New York Pier Crane Bids to be Re-advertised

Board of Estimate Fears Trouble Due to Possible Irregularity of Low Bid Submitted

On Dec. 2 the Board of Estimate and Apportionment of New York City voted to recommend to the Commissioner of Docks that the proposal to furnish thirty-four pier cranes for piers 12 and 13 of the new Stapleton (Staten Island) terminal be re-advertised. This action followed the hearing at which the next to lowest bidder on the first proposal protested against the award to the lowest bidder on the ground that this lowest bid was irregular. The Board of Estimate, from its discussion, seemed to fear legal complications if the contracts were awarded to either the lowest or next to the lowest bidder and made this recommendation to the Commissioner of Docks following his own request for advice. The commissioner has authority to let contracts on his own initiative, but he has stated that he would follow the advice of the board in this case.

The situation developed is a most interesting one to manufacturers and contractors contemplating work for the city. The proposals called for bids on thirty-four cranes, twenty-six to thirty-four of which were to be revolving 2½-ton gantries and eight to none of which were to be 1½-2½-ton combination cranes, there being five alternate bids, depending upon the number of each type to be asked for. The proposals were accompanied by specifications and outline drawings, but required that all bids should be accompanied by such general drawings and descriptive specifications "as will adequately indicate the manner in which the bidder proposes to carry out these specifications."

Twelve Manufacturers Bid

Twelve manufacturers submitted bids which were opened Oct. 4, 1921. The lowest two were from Heyl & Patterson, Inc., whose bid on one of the alternate propositions, given here merely for an example, was $370,882. The next lowest bidder was Wellman-Seaver-Morgan Co., whose bid on the corresponding item was $396,435. The variation in the other four items was approximately the same. Accompanying the Heyl & Patterson bid were a set of drawings and certain descriptive specifications. After the opening of the bids Heyl & Patterson wrote a letter to the Commissioner of Docks in which they said: "If there is any instance where any descriptive matter of what we propose to furnish conflicts in any way with the specifications themselves, the specifications of the Dock Department are to apply."

Subsequent thereto, Wellman-Seaver-Morgan wrote a letter to the Department of Docks protesting against the possible award of the contract to Heyl & Patterson on the ground that the specifications accompanying their bid would result in a structure different from and inferior to the structure required by the department's specifications and that therefore the bid was irregular and should be thrown out. They further contended that the subsequent letter to the department conforming the Heyl & Patterson bid to the Dock Department specifications was in effect changing a bid after the opening of the bids and that it should not be accepted.

The dock commissioner contended, however, that the specifications submitted by Heyl & Patterson were surplusage, that he could have required them to furnish the cranes to the department's specifications on the fact that they had submitted their bids on the regular blank forms of the department which carry along with every bid quoted the words "as per specifications," so that their specifications were mere information indicating what they would like to do but in no way binding the department to accept them. The commissioner stated this view to the Board of Estimate, but the board apparently was impressed with the possibility of legal complications, the danger of a taxpayers' suit, although the dock commissioner had an opinion from the corporation counsel stating that in his opinion the commissioner was free to accept the low bid.

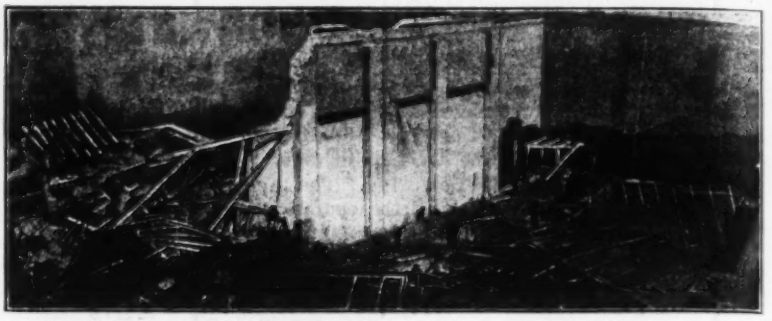


FIG. 1. GENERAL VIEW OF THE COLLAPSED STRUCTURE

Collapse of Roof of Theater Under Construction in Brooklyn Results in Seven Deaths

Building Was of Brick With Integral Pilasters Supporting Steel Roof Trusses—No Steel Failure Evident in Ruins

COLLAPSE of the steel roof framing of a theater building under construction in Brooklyn, N. Y., on Nov. 29, resulted in the death of at least seven workmen. The collapse occurred just a few minutes after the workmen had returned from lunch.

The structure, about 80 x 160 ft. in plan, which was to be used as a moving picture house, of about 1,800 seating capacity, had brick walls, its roof of reinforced tile being carried by a series of eight steel transverse trusses spaced about 16 ft. on centers and supported by brick pilasters integral with the walls. The north ends of four trusses were carried past an offset in the north wall of the building by a longitudinal truss one end of which rested on the wall pier at the angle of the offset, and the other end on a steel column. Three of the transverse trusses were supported on the upper chord of this longitudinal truss, the fourth or Truss 1 (see Fig. 2) being supported at its northerly end by a two-angle strut, stayed horizontally to the east end of the longitudinal truss. The column supporting the longitudinal truss was not anchored to the concrete footing and apparently the transverse trusses were not anchored to the brick pilasters, though holes for anchor bolts were found in each of the truss base plates.

FIG. 3. PART OF THE TOP CHORD OF TRUSS 1—BROKEN PILASTER UNDER TRUSS 6

An examination of the site after the collapse revealed that there was no

FIG. 4. SOUTH WALL AND PART OF WRECKAGE—NOTE CONDITION OF PILASTERS

diagonal bracing between trusses. The purlins used were 6-in. channels joined not on the truss centers but about 30 in. from the truss center lines. A strut connected all transverse trusses at the center of the bottom chords.

Examination of the wreckage indicates that the steel column had kicked out from its footing and lay with its base about 2 ft. off the pier. Beginning at the western end of the building and numbering the trusses in order from 1 to 8 (see Fig. 2) Trusses 1, 2, 3, and 4 had fallen eastward and their top and bottom chords described almost complete semi-circles as they lay on the ground. Trusses 5, 6, 7, and 8 had also fallen eastward though they were much less distorted than the first four trusses. However, the top chords of 7 and 8 had buckled sharply at the first panel point from the north end in two right angles. No similar distortion was noticeable in the other trusses, though the purlins kept the trusses well tied together. The cause of this buckling is uncertain.

The pilaster which supported the north end of Truss 5 had crushed partially, and the entire wall from that point to the west wall of the structure collapsed entirely. The pilaster under the south end of Truss 6 also was partially destroyed, but all the other pilasters remained intact, the plates remaining in position on the top of the pilasters in almost every case. The general position of all trusses as they appear on the ground is shown by Fig. 2.

The vertical strut which supported Truss 1 bent through an angle of 180 deg., so that the backs of the angles forming the strut rested against each other. The splice plate fastening the bottom of this strut to the west face of the column was torn through at the joint, half of the plate remaining fastened to the truss and half to the steel column.

Only at Trusses 1 and 2 of the south side of the building and Truss 5 on the north side is there any obvious or marked evidence that the ends of the trusses scraped against the sides of the masonry walls. The south end of Truss 1 scraped along the wall in an easterly direction, about half the distance from the top of the pilaster to the ground. The scraping of the southern end of Truss 2 was considerably less.

In their present positions the steel trusses are in pairs and are held approximately in their proper relative positions by the "fixed" span of the purlins. This condition is indicated in Fig. 2. The horizontal strut connecting the bottom chords of all trusses remains continuous practically throughout its length, being unbroken, though in places distorted.

It is apparent that no failure of the steel was the primary cause of the collapse. All of the main members of the steel trusses remained practically intact, or at least lacking any distortion which might have caused the collapse. The marks on the south wall indicating that the scraping of the south end of Trusses 1 and 2 can be explained by the fact that the north end of the trusses had to remain upon their supports (the longitudinal truss) and therefore required a great deal more force to push them from their pilasters than that required to disengage the other lateral trusses which rested with either end upon pilasters. The fact that the scraping was most apparent at the south end of Truss 1 would indicate that the longitudinal truss inclined slightly inward from the beginning of the failure, a fact evident by the position of the longitudinal truss and steel columns upon the ground.

FIG. 5. STEEL COLUMN AND ITS FOOTING—LACK OF ANCHORING IS OBVIOUS

The crushing of the north pilaster of Truss 5 and the south pilaster of Truss 6 may be significant. With the failure occurring in the masonry at the

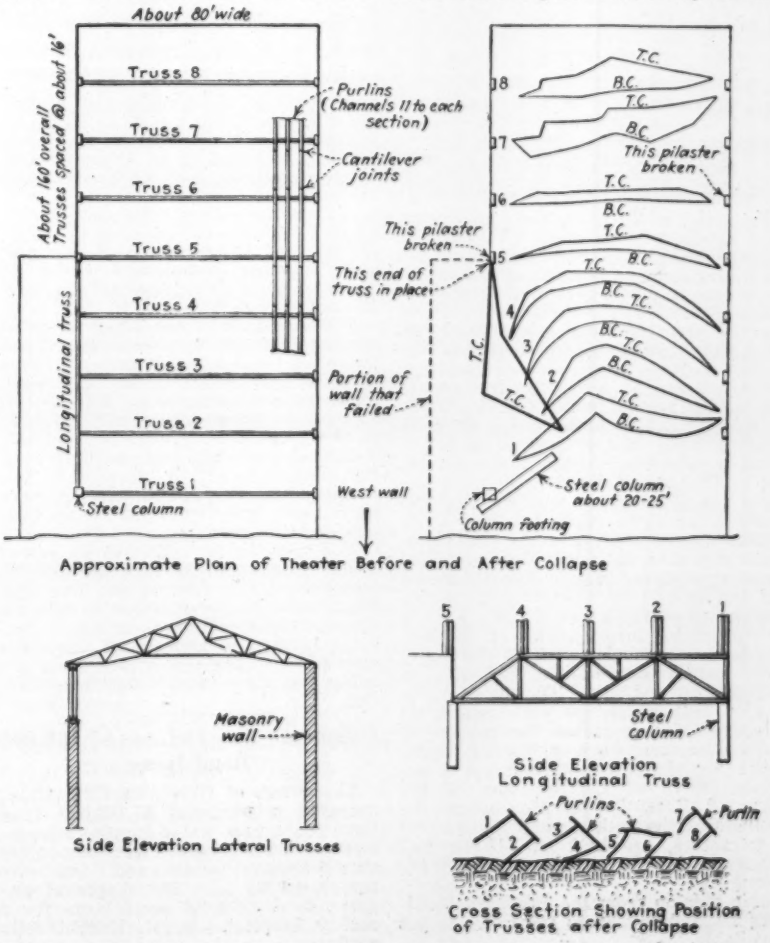


FIG. 2. GENERAL FEATURES BEFOR E AND AFTER THE COLLAPSE

General Contractors Nominate Officers for 1922

Officers for 1922 of the Associated General Contractors of America have been named by the nominating committee of the association headed by W. A. Rogers, Bates & Rogers Construction Co., Chicago, as chairman. Arthur S. Bent, Bent Bros., Los Angeles, Cal., now vice-president, is named as president, and A. P. Greensfelder, Fruin-Conlin Contracting Co., St. Louis, Mo., is nominated for Mr. Bent's unexpired term as vice-president. The other vice-presidents nominated are Sumner Sollitt, Sumner Sollitt Co., Chicago, and George A. Walbridge, Walbridge-Aldinger Co., Detroit, Mich. For treasurer Charles Cummings, Consolidated Engineering Co., Baltimore, Md., is nominated. The new directors named are: C. W. Lundoff, Lundoff-Bicknell Co., Cleveland, Ohio; B. H. Hardaway, Hardaway Contracting Co., Columbus, Ga., Stanley D. Moore, Moore-Young Construction Co., Waterloo, Iowa, and E. W. Shenk, Henry Shenk Co. Erie, Pa.

Building Trades Employers to Meet in Cleveland

The annual convention of the National Association of Building Trades Employers will be held in Cleveland, Jan. 12-14. The more important subjects to be discussed include the open shop vs. the closed shop; the contractors' association and the law, apprentices, the National Board for Jurisdictional Disputes, relations between the architect and the contractor, and wages.

Brooklyn Theater Collapse

(*Concluded from preceding page*)

north end of Truss 5, the pull at the top by the purlins and at the bottom by the horizontal strut connecting the bottom chords of the trusses would be sufficient to disengage all trusses from their pilasters. All principal members of the steel framing are undamaged, though a few breaks occurred in the bottom chords and the web members of the trusses. These breaks appear to be the result of the fall.

Despite the fact that there were no anchor bolts in the base of the steel column which supported the west end of the longitudinal truss, it is obvious that the column was well held by the trusses which it supported, and there would be no danger from the unanchored column until some lateral thrust was applied, as would have occurred in the failure of the pilaster at the north end of Truss 5.

An official investigation of the collapse is being undertaken by the Building Department of the Borough of Brooklyn, and the Queens County police authorities are endeavoring to discover if any of the contractors or subcontractors were guilty of negligence or of the use of improper materials. Both of the members of the firm of Rosenthal & Moskowitz, the owners of the building and the general contractors, are held on $15,000 bail each on temporary charges of manslaughter.

No opinion from the Brooklyn Building Department as to the cause is yet available.

Engineering Office—Club Building Planned in Denver

All this year consideration of an engineering office-club building has been before a committee of the Colorado State Engineering Council. To crystallize plans the Colorado Society of Engineers recently secured tentative plans for a 7-story building containing offices, central drafting room, blueprint facilities, technical library, auditorium seating 500, club rooms, grill and stores on the ground floor. After a canvass of possible tenants, analysis of revenues, and means of financing, the Colorado society presented its findings, which were favorable to the Council with a request for co-operating committees from the constitutent societies. The local branch of the American Society of Civil Engineers has already complied.

I. C. C. Closes Chicago Office

With its railway valuation work approaching completion the Interstate Commerce Commission closed the Central District office of its Bureau of Valuation, at Chicago, on Nov. 30. The engineering, land and accounting departments have been transferred to Washington.

League of the Southwest Schedules Colorado River Conference

A meeting for the purpose of discussing Colorado River problems has been called by the League of the Southwest for Dec. 8, 9 and 10 at Riverside, Cal. The program includes Herbert Hoover, Secretary of Commerce, O. C. Merrill, executive secretary, Federal Power Commission, the governors of Colorado, Nevada and California, A. J. McCune, state engineer of Colorado, Arthur P. Davis or F. E. Weymouth of the U. S. Reclamation Service and F. H. Newell.

The entire Colorado River Commission created by the several states and Congress is also to be present. This commission consists of W. S. Norveil, state water commissioner, Arizona, W. F. McClure, state engineer of California, R. E. Caldwell, state engineer of Utah, F. C. Emerson, state engineer of Wyoming, Honorable F. B. Davis of New Mexico, J. G. Scrugham, state engineer of Nevada, and Honorable Dolph Carpenter of Colorado.

The commission will have its initial meeting concurrently with the general meeting of the League at Riverside. Representatives and delegates from a large number of organizations interested in the development of the Colorado River will be present and plans are being laid for a representative gathering.

Oklahoma City Defeats $7,100,000 Bond Issue

The voters of Oklahoma City, Okla., defeated a proposed $7,100,000 bond issue for a new water supply, sewage-works, storm sewer extensions, river straightening, parks and new fire equipment on Nov. 26. Approval was given to a $250,000 bond issue for a county hospital. B. M. Hart is city engineer.

Motor Truck Operators Establish Union Terminal in Minneapolis

Fifteen of the principal companies and individuals operating freight motor trucks out of Minneapolis have organized the Minneapolis Truck Terminals, Inc., and established a union terminal from which their business is being conducted. Thirty-seven lines serving about fifty towns are using the terminal, which is at 724 First St., North, in space leased from the Security Warehouse Co. H. R. Belitz is president and F. P. Raymond secretary of the new concern.

Heretofore the interests represented in the joint enterprise had conducted their business from five or six separate terminals. Minneapolis wholesalers suggested to them the idea of the union terminal, stating that unless such provision were made motor truck rural service would not be considered a valuable adjunct to their trade.

It is understood that there are half a dozen truck lines, mostly small, not yet in the terminal company, but its articles are such that these can be taken in if they should desire inclusion later. Warehouse space will be rented for the present, but the company purposes to erect a building of its own.

American Concrete Institute To Meet in Cleveland

Initiating a program of holding its annual convention in various cities, the American Concrete Institute will meet in Cleveland, Ohio, Feb. 13 to 16, 1922. The program, as outlined by the Board of Direction, after considering the committee reports which are expected to be ready for discussion, will be spread over nine convention sessions—two sessions a day for three days and three sessions on a fourth day. These will be divided as follows: two sessions for contractor problems—the practical problems on the job; two sessions for concrete products manufacturers; one session on roads; one session on houses; one session on research; two sessions on engineering design and inspection.

New Water Commission for Kansas City—Bonds Fail

Although the water-works bonds for $11,000,000 voted upon in Kansas City, Nov. 22, did not receive the necessary two-thirds majority, the bi-partisan commission to operate and construct a new plant was elected. It consists of Alexander Maitland, Jr., president, Kansas City Bridge Co., and a member of the American Society of Civil Engineers; George Edwards, formerly Mayor; Louis Rothchild, a retail clothing merchant; and Hughes Bryant, a real estate man. The members, who are to receive $6,000 annually, go into office April 1, 1922.

Engineers of the city backed the water-works campaign. Machine politicians complimented the engineers by saying that they could recognize by the results the precincts in which the engineers worked and that if they could command workers like the engineers, they could "put over anything." It is generally conceded, even by the opposition papers, that the water bonds will carry in the spring election if put up by themselves and not weighed down, as they were at this election, by bonds for work not absolutely necessary.

A. S. M. E. Considers Equal Rights for Junior Members

Amendments to the constitution of the American Society of Mechanical Engineers (a) permitting junior members to vote and (b) removing the prohibition against juniors holding office were presented at the business section of the annual meeting held Dec. 7 in the Engineering Societies Building, New York.

An analysis of the society's membership shows that the average age at which juniors can join the society is over 25 years. The average age of all juniors is nearly 29 years. Seventy-five per cent of the juniors are graduates of technical schools. The proposed amendments were designed to cause a larger percentage of engineering students to join the society upon graduation and to assume an active interest in its affairs.

Argentine Proposes Internal Loan For Sanitary Work

A director of the Argentine National Sanitary Works Department has asked immediate authorization to issue 20,000,000 pesos in bonds at 6 per cent interest and 1 per cent amortization, to provide running water to fifteen towns of over 3,000 population, and both water and sewage systems for those over 8,000 inhabitants. Construction of these systems is authorized by law, says a recent report from U. S. Trade Commissioner George F. Brady, but the rate of 5 per cent interest makes it impossible to float the loan.

A. A. E. Directors Urge Support for Local Public Service

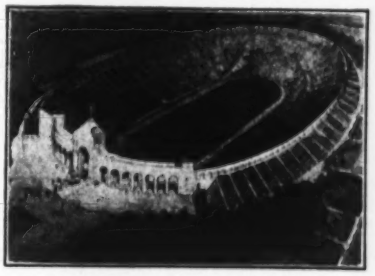
At the quarterly meeting of the board of directors of the American Association of Engineers in Chicago, Nov. 18 and 19, steps were taken to push construction and public service activities immediately through the 220 local units of the association. The meeting decided that the local organizations should stimulate construction throughout the country, especially in municipalities, in accordance with the suggestions and plans of the National Employment Conference held recently in Washington, through active co-operation with municipal, federal and state authorities.

Similar action was also directed to the end that municipal engineering service be improved through an educational campaign for: (1) More certain tenure of office. (2) Having technical engineering work supervised by engineers. (3) Putting compensation on a basis of qualifications and service rendered. (4) Insisting that only the highest grade of engineering service be accepted. (5) Extensive co-operation with local civic organizations. (6) Encouraging engineers to prepare popular articles about municipal work such as paving, sewerage, sewerage disposal, sanitation, water supply, city lighting and city planning. The point was emphasized that this educational work should be more for the general public and not so much for engineers.

First Vice-President A. N. Johnson of the Joint Committee of A.A.E. and the Federated American Engineering Societies reported that a plan of co-operation was being formulated.

Los Angeles Plans Big Coliseum

Under an agreement with the city and the county of Los Angeles the Community Development Association has undertaken to construct in Exposition Park a coliseum seating 75,000 people and costing approximately $800,000. Construction work will start immediately and will require fourteen months. The contractor is the Edwards, Wildey & Dixon Co., while the architects are John and Donald B. Parkinson. The city and county, in return for an annual rental of the structure, will have equal rights of occupancy with the development association for a period of years, at the end of which time the Coliseum will become the property of



PROPOSED COLISEUM AT LOS ANGELES

the city and county. Los Angeles banks are financing the project.

The Coliseum is to be elliptical in plan, as shown in the accompany architects' sketch, the field being about 30 ft. below, and the seats extending 50 ft. above, the ground surface. The lower tiers of seats will be of concrete construction, while wood will be temporarily employed for the upper sections until the embankment upon which they rest has become stable.

The playing field will be 680 ft. long and 344 ft. wide. There will be 86 exits and entrances.

Vehicle Tunnel and Bridge Bonds of $15,000,000 Authorized

The New Jersey Interstate Bridge and Tunnel Commission, at its meeting Nov. 29, authorized a bond issue of $15,000,000 to cover expenditures during 1922 for the Hudson River vehicular tunnel and the Delaware River bridge at Camden. According to the estimates of Clifford M. Holland, chief engineer of the vehicular tunnel, that project will require $12,793,000 during the coming year. The state's share of the bridge expenses is estimated at $2,500,000.

The commission authorized the beginning of negotiations to acquire land on the Jersey side for the installation of the tunnel construction plant, although, at the present writing, the agreement with the Erie R.R., involving the ventilating shaft site, has not yet been signed.

Tulsa Votes Bonds for $6,800,000 Water Supply Project

By a popular vote of 5,957 to 1,702 the citizens of Tulsa, Okla., indorsed a bond issue for an additional water supply, to be brought from Spavinaw Creek. The estimated cost of the project is $6,800,000. An outline of various water-supply schemes at Tulsa was published in this journal Nov. 3, p. 719.

Large Range of Bids on Yellow River Bridge

Prices From Five to Fifteen Millions Asked By 21 Bidders—Belgians Are First and Second

Details of the bidding on the Yellow River bridge called by the Chinese Ministry of Communications last spring have just been made available through publication of the figures in the *Journal* of the Association of Chinese and American Engineers (Peking) of August. The board of engineers convened to pass on the bids included five foreign engineers: H. Wilmer, former chief engineer of the Great Eastern Ry., England; J. A. L. Waddell, United States; A. Mesnager, France; L. Dethieu, Belgium; T. Ohmra, Japan.

Twenty-one bidders of nine different nationalities submitted 45 bids, including five Chinese bids, four American, three French, two British, two Japanese, one Belgian, one Austrian, one German, one Anglo-American, and one Franco-American. The bids submitted ranged from $5,000,000 to $15,000,000. The first three prizes were awarded to the Société d'Etude et de Construction, Belgium, first prize; Compagnie Générale de'Extrême-Orient, Belgium, second prize; Etablissement Brossard et Mopin, France, third prize. No fourth prize was awarded as the design which received fourth rank was submitted by the bidder who received third prize, and no competitor was permitted to receive more than one prize. The bids as quoted are:

M. Sughara, Tokyo, $14,972,229.

W. Deydier, Ire St. Gervais, France; $8,462,000 and $9,250,000.

Union d'Enterprises Industrielles, Paris, France; $9,331,263.55.

Societa Nazionale delle Officine di Savigliano, Turin, Italy; $8,310,249.31.

Sidney Y. Powell, Shanghai; $8,709,454.50; $9,952,648.

Société d'Etude et de Construction, Brussels, Belgium; $14,902,844.82; $10,881,297.10.

The East Asia Co., Dairen, China; $9,736,333.80.

Cleveland Bridge & Engineering Co., Ltd., Cleveland, England; $5,165,232.79.

Arthur McMullen Co. and Minneapolis Steel & Machinery Co.; $12,457,137.11; $13,369,720; $12,818,074.55.

Etablissement Daydé et Schneider et Cie., Paris; $10,038,665.18; $10,493,644.88; $10,690,344.25; $11,142,187.62; $10,087,182.22.

Yu Foong Industrial Development Co., Ltd., Peking; $8,927,083.44; $8,198,693.44; $8,691,983.44; $10,149,245.99; $9,230,995.99; $9,742,555.99; $10,428,846.64; $9,413,579,970; $8,336,250.

Lam, Glines & Co., Inc., New York; $9,804,187.20.

Establissement Brossard at Mopin, Paris, France; $10,846,682.60; $10,344,755.98; $10,380,472.57; $10,111,102.80; $10,700,499.18; $9,504,502.31.

Chung Hsi Engineering Office, Shanghai, China; $23,018,347.93.

F. Krupp A. G. of Rheinhausen, and Grün and Bilfinger of Mannheim, Germany; $9,481,944; $8,490,914; $8,053,400; $7,451,180; $10,786,895; $9,440,525.

The Kai Cheng Engineering Co., Peking; $14,000,000.

Compagnie Générale d'Extrême-Orient, Paris; $9,299,184.31; $10,490,981.97.

Celebrate Completion of Flood Control Work at Erie, Pa.

Erie, Pa., on Nov. 23, celebrated the completion of its Mill Creek flood control works, designed to prevent a repetition of the disaster of several years ago when the stream overflowed its banks, passing through the built-up section of the city for more than a mile and resulting in the death, by drowning, of forty people and a property loss estimated at $2,000,000.

The stream is now entirely inclosed in a 22x18-ft. concrete conduit designed and constructed under the direction of Gannett, Seelye & Fleming, engineers, Harrisburg, Pa. Streets have been graded and paved over the structure and buildings erected on ground that was formerly the open-stream channel. Many acres of land in the heart of the city have been recovered for building purposes.

The engineers in charge of the work have received from the local newspapers recognition not ordinarily accorded to technical men. The Nov. 20 issue of the *Erie Dispatch* carried on the first page a group photograph of the engineering staff and also a picture of the daughter of George K. Richards, resident engineer in charge of the improvement, who had been selected, instead of some politician's relative, to christen the new concrete tube.

California Starts Test Treatment of Road Sub-Soils

To test different methods of treating adverse sub-soils upon which paving is to be laid, the California Highway Commission is about to institute a series of experiments on a section of road now being constructed in Solano County, from Denverton to Rio Vista. Nine sections each 500 ft. long will be treated as follows:

Section 1. This section will be treated to a depth of 12 in. with portland cement in the ratio of 1 part of cement to 10 parts of soil, by plowing and harrowing to secure an intimate mixture. After having incorporated the cement with the soil, the subgrade will be rolled and finished for the concrete pavement.

Section 2. The same process will be followed as for Section 1, except that the proportions will be 1:20.

Section 3. The same process will be followed as for Section 1, except that the depth of treatment will be 6 in. instead of 12 in.

Section 4. The same process will be followed as for Section 2, except that the depth of treatment will be 6 in. instead of 12 in.

Section 5. The same process will be followed as for Section 1, except that hydrated lime in the proportions of 1 part of lime to 20 parts of soil will be used in place of portland cement.

Section 6. The same process will be followed as for Section 1, except that pulverized limestone in proportions of 1 part of limestone to 20 parts of soil will be used in place of portland cement.

Section 7. The same process will be followed as for Section 1, except that no foreign substance will be mixed with the adobe soil.

Section 8. The same process will be followed as for Section 1, except that 60 per cent asphaltic road oil will be spread at the rate of 3 to 5 gal. to the square yard.

Section 9. The same process will be followed as for Section 8, except that the depth of treatment will be 6 in. instead of 12. in.

Engineering Societies

Calendar

Annual Meetings

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Convention, Cleveland, Ohio, Feb. 13-16.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York City; Annual Meeting, New York City, Dec. 5-9.

AMERICAN ROAD BUILDERS ASSOCIATION, New York; Annual Convention and Good Roads Show, Chicago, Jan. 17-20.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 18-19.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual Conference, Cleveland, Ohio, Jan. 17-19.

FEDERATED AMERICAN ENGINEERING SOCIETIES (American Engineering Council) Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 5 and 6.

The American Specification Institute will hold its first annual conference Dec. 9 in Chicago. Subjects scheduled are on specifications from the standpoint of the law, building material and equipment industries, superintendents of construction and estimators. The purpose of the meeting is to analyze the thoughts of engineers and architests interested in the improvement of specifications for building and engineering structures and their equipment.

The Associated Pennsylvania Highway Contractors will hold their annual meeting at the Penn-Harris Hotel, Harrisburg, on Dec. 15. In connection ith the meeting a Highway Conference has been called for Dec. 16, to which engineers, contractors, material producers, equipment manufacturers bankers and surety companies are invited.

The New York Section, Am. Soc. C. E., at its Dec. 9 meeting, will consider the topic, "The Zoning Law—What It Has Done for New York." The opening address will be by Edward M. Bassett, counsel of the New York Zoning Committee, and the other speakers will be Rudolph P. Miller, superintendent of buildings, Borough of Manhattan, Lawson Purdy, secretary and general director, the Charity Organization Society of the City of New York; John P. Fox, executive secretary, the Murray Hill Association, Inc.; and Clarence S. Stein, architect.

The New England Water Works Association, at its Dec. 14 meeting in Boston, will be addressed by Peter Payne Deane, New York City on, "Electrical Operation and Control of Gate Valves for Water-Works Systems," and by Thomas H. Wiggin, consulting engineer, Scarsdale, N. Y., on "Two Years in China."

The New England Road Builders' Association will hold its first annual dinner at the Hotel Somerset, Boston, Dec. 15.

Personal Notes

E. N. NOYES, consulting engineer, Dallas, Tex., has been appointed engineer for the Dallas Property Owners Association, an organization of business houses in the retail and wholesale district of Dallas, for the promotion of traffic ways, paving, new businesses, etc. He will continue as district engineer, City of Dallas Levee Improvement District 10, and will maintain his connection with the firm of Myers & Noyes, engineers.

COL. THOMAS H. REES, Corps of Engineers, U. S. A., has been transferred from San Francisco, Cal., to Honolulu, T. H., for duty as Commanding Officer of the 3rd Engineers.

LT.-COL. PAUL S. BOND, Corps of Engineers, U. S. A., has been transferred from New York City to Cleveland, Ohio, for duty as instructor, Engineers, Ohio National Guard.

ISAAC MENLINE, consulting engineer, formerly engineer of design and construction for the Garment Center Capitol Buildings, New York City, and for several years prior thereto assistant engineer in the Bureau of Buildings, Manhattan, announces that he has opened an office in New York City for the practice of engineering.

JAMES M. OWENS, highway engineer, city engineer's office, San Francisco, Cal., has left for Honolulu to act in a consulting capacity for the City of Honolulu on paving work.

MAJOR THOMAS B. LARKIN, Corps of Engineers, U. S. A., has been transferred from Washington, D. C., to Tokyo, Japan, for duty as assistant military attache, American Embassy.

MAJOR THOMAS M. ROBINS, Corps of Engineers, U. S. A., has been detailed as a member of the board of officers to consider a system of national highways in connection with the rural post roads.

W. H. SCHIMMEL, formerly engineer, maintenance of way, Monongahela Valley Traction Co., Fairmont, W. Va., is now chief engineer of the Keeley Construction Co., Clarksburg.

C. H. BIRDSEYE, chief geographer for the U. S. Geological Survey, left Washington Nov. 30 to inspect the mapmaking activities of the Survey in the West and in Hawaii.

GEORGE H. HARRIS, engineer of track and maintenance of way, has been appointed assistant chief engineer of the Michigan Central R.R., with headquarters in Detroit, Mich.

COL. CHARLES W. KUTZ, Corps of Engineers, U. S. A., upon being relieved from his duties as engineer-commissioner, District of Columbia, by Col. Charles Keller, has been ordered to Cincinnati, Ohio.

JOHN R. LEIGHTY, assistant to the vice-president, Missouri Pacific R.R., has been appointed chairman of the engineering committee of the Western group, Railway Presidents' Conference Committee on Valuation, with office at Chicago. He succeeds Howard C. Phillips, who has resigned.

JOHN F. DELANEY, formerly Transit Construction Commissioner of New York, has been appointed Commissioner, Department of Docks, suc-

ceeding Murray Hulbert who last month was elected President of the Board of Aldermen, of New York City.

W. G. THOMPSON, former state highway engineer of New Jersey resigned his connection with the Lakewood Engineering Co. of Cleveland on Nov. 15. He will devote some weeks to research work, and will continue as consulting highway engineer for the Lincoln Highway Association on the development of its proposed "Ideal Section," with headquarters in Trenton, N. J.

OBITUARY

SEPTIMUS P. TUSTIN, a senior member of the firm of S. J. Martinet & Co., Baltimore, Md., civil engineers and surveyors, died Nov. 18.

WILLIAM FRENCH DOHERTY, an American engineer resident in Galveston, Texas, is reported by the State Department to have been killed, presumably by rioters, in Bombay, India, on November 19.

CHARLES H. PRIOR, railroad builder, died Nov. 13 in Minneapolis. He was 88 years old and had been a resident of Minneapolis for 50 years. Under his direction, the first line of the Chicago, Milwaukee & St. Paul Ry. was brought into Minneapolis in 1870.

PAUL M. NORBOE, assistant state engineer of California since the organization of the department of engineering in 1907, died Nov. 15. He was born in El Monte, Cal., in 1857 and began his engineering work as a chainman with a government surveying party in the Mojave district in 1877. About five years later he became assistant engineer of construction of canals in Fresno and Tulare Counties, Cal. and served for four years as city engineer of Visalia. Most of his experience was in irrigation and reclamation work.

JOHN B. BATTLE, assistant engineer, U. S. Engineer Office, Mobile, Ala., died Nov. 6. He was born in Sumter County, Ala., in 1875, and from 1895 to 1900 was engaged in surveying work, part of this time with the Seaboard Air Line R.R. From 1900 to 1910 he was with the Engineer Department of the Army on the surveys and construction of Locks 6, 7, 8 and 9 in the Warrior River, Ala., and from 1912 to 1915 was engineer in charge of construction of Locks and Dam No. 17, Black Warrior River. Later he was made engineer in charge of construction of fortifications at Ft. Morgan, Ala.

DR. BINGHAM H. STONE, director of the Vermont Laboratory of Hygiene, died late in October at Burlington, Vt. He took the degrees of A.B. in 1897 and M.D. in 1899 and, later on, of M.S. at the University of Vermont. After post-graduate work at several institutions, he began service with the Vermont Board of Health and continued until his death, as laboratory assistant in 1900, bacteriologist from 1901 to 1904, and then as director. He had been professor of bacteriology since 1904 and of pathology since 1910 in the Medical College of the University of Vermont and university trustee since 1919. He was author of several books on laboratory work.

BUSINESS NOTES

B. J. WINTERS, for 20 years connected in an engineering and sales capacity with the F. C. Austin companies, is now in charge of the Northwest district of the Austin Machinery Corp., with office in Minneapolis.

PAYNE DEAN, LTD., New York City, manufacturer of Dean control for electrical operation of water, gas and high pressure steam valves, has established offices in Pittsburgh and Chicago, with C. J. Burrage, recently with the Cutler-Hammer Mfg. Co., in charge of the Pittsburgh office and A. H. Kohlbusch in charge of the Chicago office.

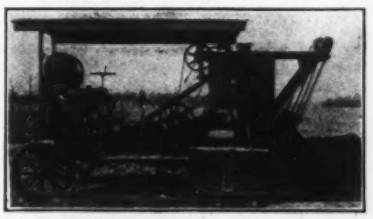
H. V. SCHIEFER, who has been connected with the C. O. Bartlett & Snow Co. as chief draftsman, the Grasseli Chemical Co., Cleveland, as labor-saving engineer, and with the Arthur G. McKee Co., Cleveland, as manager of the sintering plant department, has been placed in charge of the Philadelphia office of the Webster Manufacturing Co., Chicago, engineers, founders and machinists.

THE UNITED STATES CAST IRON PIPE & FOUNDRY CO., Burlington, N. J., announces the opening of an office in Cincinnati, O., with Harold G. Henderson in charge of sales.

EQUIPMENT AND MATERIALS

New Small Trench Excavator

A trench excavator designed to excavate trenches 12, 15 and 18 in., wide and up to 6 ft. deep has been developed by the Parsons Co., Newton, Iowa. The new machine weighs 12,000 lb. and is only 25 ft. long with the boom extended.



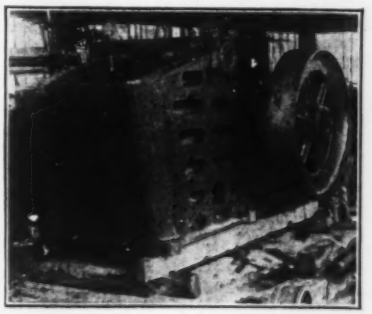
Being carried on crawler tractions, with broad tired wheels under the front or light end, safe operation on soft ground and ability to make short turns are considered to be assured. A four-cylinder 30-hp. gasoline engine provides power. Two special structural and operating details are a fiber friction-disk slip-clutch on the main shaft which slips when obstructions are encountered, and a two-chain arrangement, cushioned by springs, for adjusting the bucket boom. The machine has twelve digging speeds from 1 ft. to 9 ft. per hour and a traveling speed of 1½ miles per hour.

Gasoline Electric Shovel

A gasoline engine direct-connected to a dynamo which supplies current to three motors is the power plant employed on a new revolving shovel being marketed by the Marion Steam Shovel Co., Marion, O. A separate motor is used for hoisting, rotating and crowding, a controller having movements identical with the levers on a steam shovel being employed. In fact the machine is structurally a steam shovel with a four-cylinder gas engine and dynamo in place of the boiler, a controller in place of the lever bank and three motors in place of the usual steam engines. The gas engine is 53 hp. and the generator 25 kw.

Hinged Joint for Jaw Crusher Frames

A new frame construction designed to reduce breakage in jaw crushers has been developed by the Kennedy-Van Saun Manufacturing & Engineering Corp., New York, N. Y. Instead of the usual single-piece casting or



four-piece frame, with bolted mortise and tenon joints, hinged joints are employed. The extremities of the frames are made circular and fastened together by steel pins, which given enough hinge action to the joint to take care of slight movement of the end frames under heavy crushing strains. With this hinge joint construction additional bolts and stiffeners are employed to maintain shaft alignment and the essential rigidity needed in a crusher frame.

Out of the Ordinary Trade Publications

Details of practice in mixing and laying sheet asphalt pavements are described in a 15-page illustrated pamphlet issued by the TEXAS CO.

Practical methods of waterproofing are illustrated and described in a pamphlet issued by the MINWAX CO., INC., New York.

Discussion and instructions of practical value are contained in a pamphlet on protective coatings for pipe, particularly for underground service, by the NATIONAL TUBE CO., Pittsburgh, Pa.

A series of pamphlets from the TRUSCON STEEL CO., Youngstown, Ohio, furnishes useful data on the selection and installation of steel sash. A pocketbook lists and gives the properties of all the products of the company.

The tyro in steam and gas engine lubrications is given two useful textbooks in recent publications of the VACUUM OIL CO., New York, called "Stationary Steam Engines" and "Oil Engines." Contractors in particular should get the oil engine pamphlet.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Engineering News-Record's Cost Index 1918 to Date

Engineering News-Record's Construction Cost Index Number for the months of 1920 and 1921 was published in the Nov. 24 issue, p. 876. The Numbers are here tabulated for all the months from January, 1918, to date. Next week, Dec. 15, there will be an article in these pages showing the standard European index numbers (Germany, England, France and Italy) compared graphically with Dun's "all commodities" index and *Engineering News-Record's* Construction Cost Index Number. The *E. N. R.* Index Number for the months of 1917 will be presented here next week.

ENGINEERING NEWS-RECORD CONSTRUCTION COST INDEX NUMBER (100 in 1913)

	1918	1919	1920	1921
January	184.51	198.05	206.55	230.87
February	184.51	201.50	225.10	230.67
March	184.51	198.05	240.85	224.27
April	186.01	191.25	265.20	213.07
May	186.01	191.25	268.90	210.82
June	186.31	191.85	273.80	209.82
July	188.65	193.65	265.65	203.82
August	193.85	196.65	252.00	193.07
September	193.85	202.85	255.20	188.27
October	193.85	202.25	255.20	182.57
November	193.55	206.85	255.32	166.32
December	194.75	206.85	251.62	167.82

Bids Wanted on Big Jobs

Among the jobs on which bids are asked, or will soon be asked in Construction News, pp. 249 to 257, are the following: Street and road work in Ontario to the value of $5,000,000 for Department of Provincial Highways, Toronto; sewers aggregating 31,317 ft. for Philadelphia, amounting to $386,900; ore dock for Superior, Wis., $2,000,000; power and distribution equipment for New Orleans Railway and Light Co., $972,000; hospital for University of Wisconsin, Madison, $1,200,000.

Steel Car Orders

Orders for 127 modern steel passenger cars have been placed with the Chicago, Burlington & Quincy R.R., according to a recent announcement. Cars were ordered in expectation of increased business next summer.

Materials—Production and Stocks

Chief Interest in Lumber—Stock Conditions of Basic Construction Materials in Ten Cities

With the steel industry working at only 40 to 50 per cent capacity, and with mill stocks of finished cement amounting to four to five million barrels, principal interest at present centers in the lumber industry. Steel prices have been declining in step with falling demand; cement prices were recently lowered at many mills; but lumber prices are advancing.

One hundred and eight mills reporting to the West Coast Lumbermen's Association for the week ending Nov. 26, show 59,577,331 ft. of lumber produced; 56,644,824 ft. sold and 52,286,897 ft. shipped. Production was 26 per cent below normal; new business was 5 per cent below production, and shipments were 12 per cent below production. Forty-four per cent of the new business is to be shipped by water. Orders and shipments of Southern pine are well maintained, while production and stocks show decrease.

Reports from 102 manufacturers throughout the country show common brick production 82,000,000 for October, with movements from yards amounting to 80,000,000, according to the Common Brick Manufacturers' Association of America. Burned brick on hand aggregated 230,557,000, with orders for 163,442,000.

The accompanying tabulation does not include sand, gravel and crushed stone for the reason that these materials are nearly always supplied locally in any quantity desired.

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (cement, Boston, 12,000 bbls.); time required for delivery of carload lots to city job, example: (cement, Boston, 5 to 7 days); and stocks on hand in general terms, example: (sewer pipe, Denver, plenty.)

	New York	Boston	Detroit	Chicago	Minneapolis	Denver	Atlanta	Birmingham	Los Angeles	San Francisco
Sewer pipe	Plenty	8 to 10 days	Plenty	.....	.....	Plenty	.....	Plenty	24 hrs.	Sufficient
Cement	24 hrs.	12,000 bbls. 5 to 7 days	100,000 bbl.	Few hours	2,500 bbl., prompt	7,000 bbl., 48 hr. plant to city	10 to 15 cars, prompt	2,000 bbl., 1 to 2 days	Local plant	Sufficient
Lime (common)	Ample	2,000 bbl., 5 to 8 days	5,000 tons	.....	Plenty	.....	5 to 6 cars, Prompt	4,000 bbl.	.....	Fair
Lime (hydrated)	Ample	175 tons, 5 to 8 days	Plenty	.....	Plenty	.....	Incl. in above prompt	Incl. in above	.....	Fair
									6,000,000, 6 to 8 hours. Monthly sales	
Common brick	24 hrs.	60,000	15 cars	24 hours	5,000,000 pr.	9,000,000	.....	Plenty	14,000,000	Plenty
Hollow tile	Enough	.....	Average	1 to 6 days	.....	.....	3 to 4 days	Plenty	500,000 tons	Sufficient
Lumber	Can deliver 300 M ft. in 9 or 10 days	Large retail stocks. Spruce: 10 to 14 days, yel. pine: 4 to 6 weeks	10,000,000 ft.		90% normal, 50,000,000 ft. Coast or South, 21 da. Minn. or Wis., 10	Ample though 70 per cent normal	10,000,000 ft. prompt	Large mills within 200 miles	2 to 4 days	Sufficient

Stock Conditions in Ten Cities

New York — Material stocks generally large. Structural steel available in large quantities on short notice. Stock of wrought steel pipe not large within city limits. Cement warehouses full; 24-hour deliveries to contractors within Metropolitan District. Dealers' stocks of sand, gravel and crushed stone, within city, sufficient to meet all contractors' demands. Pine lumber stocks good, can complete delivery on quantities as large as 300,000 ft. in 9 or 10 days within Metropolitan District. Common brick on hand to fill all demands within 24 hours. Hollow tile supplied by large factories within 26 miles of city.

Boston—Brick stocks low, brick being sold as fast as made by two local plants.

Philadelphia — Building material stocks generally plentiful. Not much sewer pipe on hand, but demand will be light until spring. Good demand for paving stone and for the common grades of soft woods. Finishing lumber and hard woods scarce.

Detroit — Practically no stocks of asphalt carried except by paving contractors. Large supply of river sand on docks for winter; same for gravel and crushed stone. Large stocks of brick at local plants; some contractors make their own common brick.

Chicago — Orders for structural shapes and rivets can be filled in a few hours; 200,000 tons reinforcing bars in stock. Gravel and sand can be delivered in carload lots in two to four days; crushed stone in a few hours, stocks being 300,000 cu.yd. Dealers say October and November were the two best months of this year.

Minneapolis—Stocks generally good. Cement manufacturers can deliver promptly. Common and face brick plentiful, though 20 to 30 per cent less than a year ago at this time. Some dealers state that stocks are being kept low in anticipation of a freight reduction. Lumber situation noted in the tabulation holds for St. Paul as well as for Minneapolis.

Denver—About 1,000 tons structural shapes in stock. Mountain States Lumbre Dealers' Association reports stocks 70 per cent normal; the principal Denver firm has nearly 16,000,000 ft., b.m., in stock. Sewer pipe made in city.

Atlanta — Lumber, cement, lime, brick and steel can be delivered on demand. Other materials in about a day.

Birmingham—Cast-iron pipe cast in several plants in the district. Sewer pipe is manufactured in North Birmingham. Sand is shipped in from Central Alabama, and there is no local supply. Crushed stone is available at a crushing plant in the city, but slag is used in place of stone and gravel. Slag is furnished principally by the Birmingham Slag Co., Ensley, Ala. Cement is available at the Atlas Portland Cement Co.'s plant at Leeds, Ala., 21 miles from Birmingham. Reinforcing bars are rolled at Bessemer, Ala.; structural shapes rolled at Bessemer and Fairfield plants. Several brick plants in the city. Large wholesale stocks of lumber always in local yards, and unlimited supplies are available in a radius of 200 miles.

Los Angeles — Sand, gravel and crushed stone can be delivered within 24 hours. The local cement plant can produce 6,500 bbl. per day.

San Francisco — Ample stocks of nearly all materials. Cast-iron pipe is supplied from the iron districts in about 90 days. Road oils can be delivered in about a week.

Trend of Business

That money is easier, that credit is more liberal, is evident to those who have read *Engineering News-Record's* "Trend of Business" published weekly in this section for the last month. Call loan rates have been generally downward since the early part of 1920—from 10 per cent to the present 4½ per cent. In 1915 the rate was 2 per cent and under, the climb beginning in June, 1916. For several weeks the bond market has been remarkably strong. In fact, new securities have been readily sold at prices yielding smaller returns than for many months before. It is interesting to note that Stock Exchange call money rates declined before bond prices began to rise.

On Nov. 4 the New York Federal Reserve Bank lowered its rate from 5 to 4½ per cent on all classes of paper, and reductions of ½ to 1 per cent were made at about the same time by all other Reserve Banks. Present discount rates are: 4½ per cent for New York, Boston and Philadelphia; 5 per cent for Cleveland, Chicago, St. Louis, Kansas City and San Francisco; 5½ per cent for Minneapolis, Richmond, Atlanta and Dallas. According to the "Monthly Review" issued by the Federal Reserve Bank, New York, this reduction was followed by a decline of ½ per cent (to a range of 5½ to 5½ per cent) in the open market on prime commercial paper, with 5 to 5½ per cent the prevailing rate in the last week of November. The following interesting table is given of the advance in the value of Liberty bonds:

Issue	Closing Price Nov. 19	Advance Since Oct. 20	Advance Since Low	Date of Low
Liberty 3½s	95.20	$3.64	$9.20	June 2, 1921
Liberty 1st 4s	94.88	2.28	11.88	May 19, 1920
Liberty 2d 4s	94.66	2.26	13.26	May 20, 1920
Liberty 1st 4½s	95.10	2.32	11.10	May 20, 1920
Liberty 2d 4½s	94.76	2.52	13.66	May 20, 1920
Liberty 3d 4½s	96.34	1.80	10.74	Dec. 20, 1920
Liberty 4th 4½s	94.88	2.46	12.88	May 20, 1920
Victory 4½s	99.92	0.52	5.22	May 20, 1920
Victory 3½s	99.90	0.52	5.26	May 20, 1920

Evidence of the increasing demand for fixed-income securities was shown by the heavy over-subscription to the $50,000,000 New York Telephone Co. refunding mortgage 6s, noted in these pages, Nov. 24. Of nearly 68,000 subscribers, more than 54,000 asked for bonds of $5,000 or less, to a total of more than $126,000,000, and over 25,000 asked for bonds of $1,000 or less, totaling over $22,000,000. Demand for state and municipal issues exceeded the supply, despite exceptionally heavy issues. Prices rose, so that the better grades were offered to yield about 4¼ per cent, against 5 per cent a month ago, and 5½ per cent in September.

Indications are that 1922 will be a "bond year." Last week's sales averaged $24,000,000 per day. The distribution in the last three months has been safe; bonds have gone out of Wall Street and scattered from one end of the country to the other. Inquiry for high grade issues is not slackening. Last week's features were the sale of $10,000,000 of Detroit's 4½s, 5s and 5½s; $4,000,000 Michigan highway 5s; $3,500,000 Jersey City 5s; and $2,000,000 each of New Jersey and Philadelphia 5s. The yields average 5 per cent. There were twenty-six separate issues of State and municipal bonds during the week. It is said of the present financial situation that "the speculator is poor and the investor rich."

Representative Public Bond Sales in November

Despite a flood of offerings, there is a tremendous demand for high grade bonds of all kinds. The general situation is outlined in the "Trend of Business" on this page. Municipal issues are the feature in the first half December. On Dec. 7 Rochester offered $6,000,000 one-to thirty-year 4½s; on Dec. 12 Mississippi will award $1,500,000 general improvement 5s, average maturity 13½ years; on Dec. 15 Buffalo will award $7,360,000 general improvement 4½s. The accompanying tabulation presents some representative sales of November.

REPRESENTATIVE BOND SALES OF NOVEMBER, 1921

State	Purpose	Amount	Maturity	Rate per Cent	Sold for	Dated
California	Highway	$5,000,000	1938-42	5½	109.52	Oct. 27, 1921
South Dakota	Highway	1,000,000	1931	5½	102.15	Nov. 15, 1921
County						
Big Stone, Minn.	Court House	20,000	1931	5½	100.35	Nov. 1, 1921
Churchill, Nev.	Road	25,000	1923-32	6	100.40	Oct. 1, 1921
Clark, Ind.	Highway	17,900	1923-27	6	100.59	Sept. 28, 1921
		35,200	1923-32			
Cook, Ill.	Road	2,000,000	1925-40	4½	97.6913	Apr. 1, 1920
Dallas Co. Road Dist. No. 1, Texas	Road	2,700,000	.....	5½	96.75	Oct. 27, 1921
Jefferson, Ala.	Road	80,000	.....	5	100.00	Nov. 1, 1921
Lake, Ind.	Gravel Road	12,000	.....	5	100.00	Sept. 15, 1921
Miami, Ohio	Power Plant	8,200	Due serially	6	100.00	Oct. 1, 1921
Ogemaw, Mich.	Road	28,500	Due serially	6	100.00	Oct. 1, 1921
Uvalde, Tex.	Road	200,000	1921-51	5½	100.00	Oct. 10, 1919
Bergen, N. J.	Road and Bridge	644,000	$34,000-1923-30 $49,000-1931-33 $50,000-1934-38	5½	104.01	Dec. 1, 1921
Cocoa Beach Special Road and Bridge District	Road and Bridge	300,000	1930-40-50	6	98.57	Oct. 1, 1920
Brevard Co., Fla.						
Municipality						
Boston, Mass.	Building Library	$10,000	1922-31	4½	100.00	Oct. 1, 1921
Brush, Col.	Power Plant	60,000	1942	6	100.00	Oct., 1921
Canton, Ohio	Street Improvem't	4,500	1923-52	6	100.51	Oct. 31, 1921
		3,569	1926			
Eaton, Ohio	Street Improvem't	3,000	1923-28	6	100.00	Oct. 1, 1921
Indianapolis, Ind.	Park	86,000	1926	6	102.055	Aug. 22, 1921
		65,000	1923-44	5½	101.25	Dec. 1, 1921
Logansport, Ind.	Park	13,000	1923-31	6	102.40	
	Power Plant	50,000	1922-31	6	101.702	Oct. 1, 1921
Pomona, Cal.	Streets	200,000	.....	5½	100.00	Oct. 27, 1921
Randleman, N. C.	Municipal imp'vt.	6,600	1923-42	6	100.00	Sept. 1, 1921
Sayre, Okla.	Light, water, sewer	74,500	1946	6	100.00	July 1, 1921
Seattle, Wash.	City Improvement	462,015	1933	6	100.00	Oct. 24, 1921
Verona, N. J.	Library	15,000	1923-37	6	103.096	Oct. 1, 1921
White Plains, N. Y.	Sewer	50,000	1924-28	6	103.188	Oct. 1, 1921
Asbury Park, N. J.	City Improvement	100,500	1927	5½	100.38	Nov. 15, 1921

Wilmington Unemployed Get Work

In an effort to relieve the unemployment situation the Street and Sewer Department, Wilmington, Del., has called on all property owners in the city to have pavements laid. Where the owners fail to comply with the city's request, the city will have the work done and lien the properties. It is expected that this will provide $200,000 worth of paving work.

Next Week—"Index Numbers of America and Europe Compared."

Landis Award Enforcement League Makes Power Felt

Union control of building in Chicago is doomed, in the opinion of those who are in a position to know, if the citizens committee stands by its decision to make contractors and unionists alike carry out the provisions of the award made by Judge Landis several months ago regarding wage schedules and working conditions in the building trades. This fact was brought out in a meeting December 1 in Chicago of about twenty-five secretaries and executive officers of construction interests and material associations, constituent members of the National Federation of Construction Industries by John J. O'Leary of the Citizens' Committee for the Enforcement of the Landis Award. Mr. O'Leary outlined the work accomplished in which he indicated that both unionists and contractors who are refusing to abide by the Landis rules of working conditions as well as wage scales were finding things difficult.

As an indication of what has been accomplished so far by the citizens committee nearly 1,500 carpenters are working in accordance with the award and in defiance of their union. They are protected by 175 guards furnished by the committee. Surveys of jobs are being made and 83 per cent of the

ork in Chicago is now reported operating under the Landis agreement. An apartment house builder who had all but closed a $1,000,000 bank loan was refused the money on his declaration that he proposed to ignore the Landis award. After three days' reflection he changed his mind. The majority of financial houses are behind the award. Work on the new Federal Reserve bank building, which is one of the largest unfinished pieces of construction in the downtown district, is to be carried forward in accordance with the Landis provisions.

The committee has incorporated and proposes to stay in operation several years if necessary. A fund of $3,000,000 is being raised to be paid in 10 per cent installments.

Merger of Steel Companies Likely

A merger of seven independent steel companies, mentioned as being likely within the next few months, would bring together companies which are rated as having a steel ingot capacity of 9,800,000 gross tons a year. The companies mentioned are Midvale, Lackawanna, Republic, Youngstown Sheet & Tube, Brier Hill, Inland & Steel and the Tube Company of America.

The country's total ingot capacity is about 52,500,000 tons divided into 22,500,000 tons for the United States Steel Corporation and 30,000,000 tons for the independents, so that the proposed merger would involve one-third of the independent capacity.

Dwelling House Construction Increases in 1921

A decided increase in the construction of dwelling houses throughout the country during the first ten months of 1921 has been noted according to information obtained by the civic development department of the Chamber of Commerce of the United States. Construction figures furnished by forty-four important cities show that during the period from January to October, inclusive, about $603,000,000 went into new construction, while during all 1920 the total at the same cities was only $8,000,000 more. During the shorter period this year 57.9 per cent of the total was for dwelling houses as against 36.1 per cent in 1920.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of December 1, the next, on January 5.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products:									
Structural shapes, 100 lb	$2.78	$4.00	$4.00	$2.88	$3.06	$3.75	−$3.45	−$3.75	$4.00
Structural rivets, 100 lb	−3.50	5.25	5.50	3.43	4.15	4.25	5.50	4.25	6.50
Reinforcing bars, ¾ in. and larger, 100 lb	2.68	3.20	3.50	2.68	3.08½	3.57½	2.90	3.75	−2.75
Steel pipe, black, 3½ to 6 in. lap, discount	−54%	57.65%	45%	57%	58.9–5%	38%	51.8%	50%	35.10
Cast-iron pipe, 6in. and over, ton	47.30@48.30	+45.00	54.30	42.60@44.10	47.80	52.00	50.00	+55.00	60.00
Concreting Material:									
Cement without bags, bbl	−2.30	2.69	2.55	1.97	2.26	3.10	2.84	3.10	+3.16
Gravel, ¾ in., cu.yd	1.75	1.85	2.25	1.65	1.50	2.50	2.25	1.50	1.50
Sand, cu.yd	1.00	1.25	2.25	1.65	.50	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.80 to 1.90	2.00	3.20	1.60	2.25	3.50	2.25	3.00	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	47.50	38.00	37.00	48.00	35.00	50.00	−29.00	22.00	120.00
Lime, finishing, hydrated, ton	16.99	19.00	25.00	18.00	29.00	30.00	22.00	27.00	21.00
Lime common, lump, per bbl	3.39@3.69	1.50	2.75	1.40	1.40	2.95	1.90	3.25	−11.00
Common brick, delivered, 1,000	−17.40@18.40	9.00	12.72	11.00	17.00	14.00	18.00	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	.0675	.124	.0821	−.0792	.09	.12½	.10	.08@.29
Hollow partition tile 4x12x12, block	.11120	.0675	.124	.0657	....	.10	.14½	.11	.....
Linseed oil, raw, 5 bbl. lots, gal	.72	.79	.85	−.74	.80	−.90	.83	79	.85
Common Labor:									
Common labor, union, hour	.75	.35	.....	.72½	.50	.50@.55	.75	.50@.60	....
Common labor, non-union, hour	.....	.20	.35@.45	.35@.40	.50	.35@.40	50@.55	.50	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or − signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent, 45@50 means a range of 45 to 50 per cent. Charge of 15c. per 100 lb. for cutting reinforced steel into 2-ft lengths or over. **New York** quotations are delivered except tiles, which are "on trucks." Common lump lime per 180-lb. net. **Dallas** quotes lime hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement delivered to contractors on job. **Chicago** quotes hydrated lime in 50-lb bags; common lump lime per 180-lb. net. **Minneapolis** quotes on fir instead of pine. Brick and hollow tile delivered. Cement on cars; $2.45 delivered. Gravel, sand and crushed stone quote at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized. **Denver** quotes cement "on tracks"; gravel and sand at pit, stone on cars, lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. Common lump lime per 180-lb. net. **Atlanta** quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 280-lb. net; both lump and hyper 180-lb. bbl. Steel, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. **San Francisco** quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to contractors in yards at San Francisco. **Seattle** quotes on Douglas fir instead of pine. Lump finishing lime per 180-lb. net. **Montreal** quotes sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile, per ft. Cement price is in Canadian funds (the Canadian dollar stands at 91.2 cents). Bag change is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net.

Changes Since Last Week

Present low mill prices of structural steel are being gradually reflected in warehouse quotations throughout the country. Pittsburgh continues to quote $1.50 on steel shapes and reinforcing bars in large tonnages and $1.60 per 100 lb. in small lots. Quotations on mill shipments remain unchanged.

Structural rivets are quoted in New York warehouses at $3.50 as against $3.70; steel shapes in San Francisco at $3.45 as compared with $3.70, and in Seattle at $3.75 instead of $4, one week ago. In Montreal reinforcing bars are quoted at $2.75, a reduction from $3.25 per 100 lb.

Increased discounts on black steel pipe are quoted in New York. Cast-iron pipe has advanced $2 per ton in Seattle.

Cement has dropped 10c. in New York and advanced 4c. per bbl. in Montreal. A decrease of $4 per ton is quoted on common lump lime in Montreal. New York quotes common brick at $17.40@$18.40 per 1,000 delivered. Slight declines in hollow building tile are reported in Minneapolis.

Denver and Chicago both quote reductions of 2c. per gal. in linseed oil.